MAY 6 1935

Engineering News-Record

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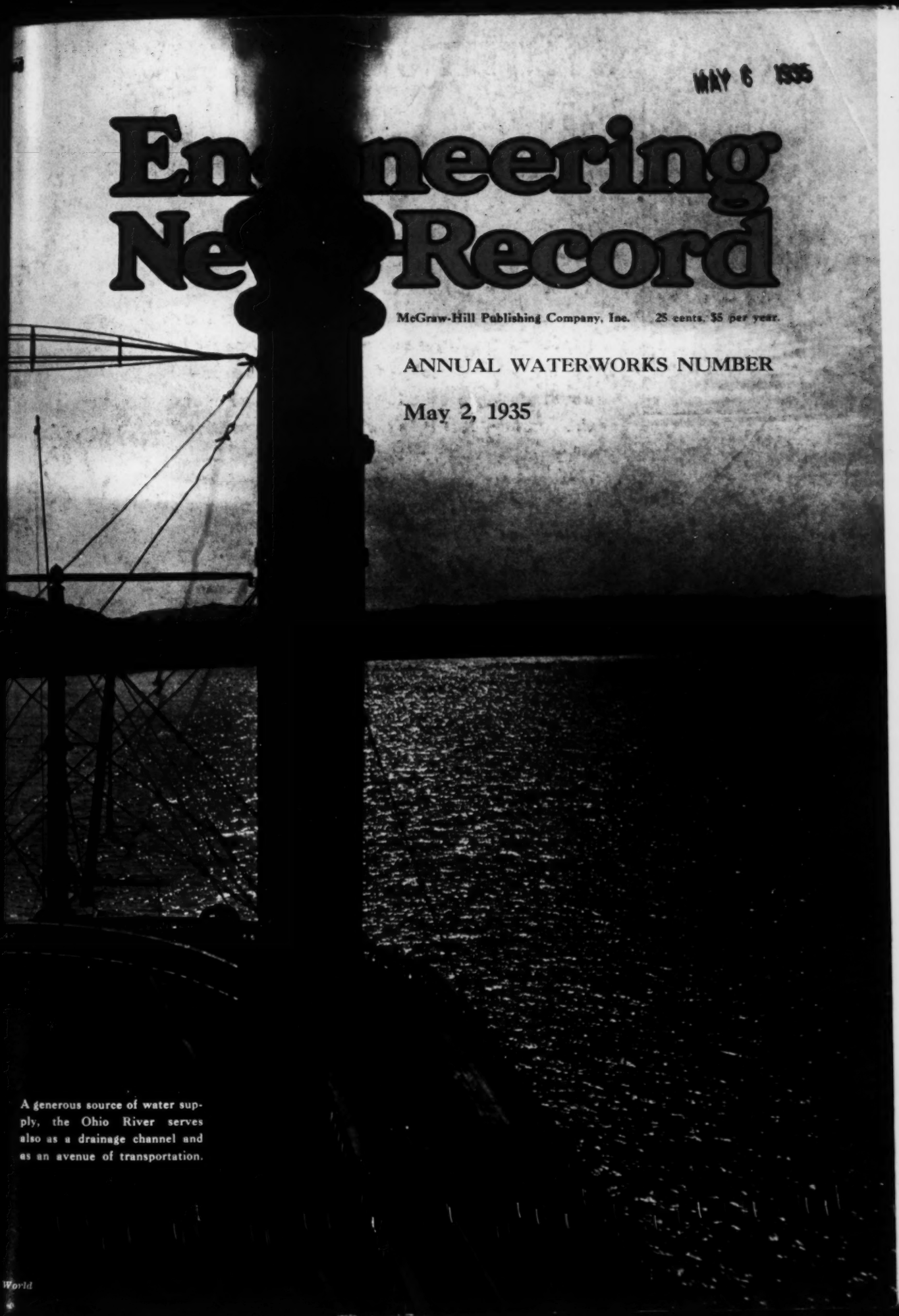
ANNUAL WATERWORKS NUMBER

May 2, 1935



A generous source of water supply, the Ohio River serves also as a drainage channel and as an avenue of transportation.

World

ON THE JOB—IT'S A SHOW-DOWN

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How Shall They Train for Tomorrow?

DURING the last few years a vast deal of thought and discussion has been devoted to the causes and effects of business depression. But, naturally enough, we have been so preoccupied with its more immediate financial, industrial and social effects that we have had little opportunity to consider what it may mean to engineering education and training. Is not this a time for earnest and thoughtful study in this important field?

Business inflation and deflation, those complementary aspects of the business cycle, are inherently related to the function of capital investment and its financial processes. The engineer is peculiarly the servant of that function and of the industries dependent upon it. When they expand, he prospers; when they languish, he is in trouble. No one is more deeply concerned with this vital process of investment in productive wealth.

RECOVERY from the present visitation and the erection of safeguards against future depressions must center on this process. But much of the fumbling of the New Deal has resulted from inadequate or warped understanding of its significance. In a period of want and distress we have sought to enforce scarcity. Producers have been encouraged to restrict productive processes in order to maintain scarcity prices while consumers lack buying power. Invested capital has sought safety by throttling the flow of new capital into its industry. We have tried to avert the penalties of financial indiscretions and excesses by freezing technical practice and by closing the field of productive industry to competitive enterprise. And while, in the name of recovery, we thus have promoted scarcity, we have paralyzed the capital industries and increased unemployment by disbanding the industrial armies that have won every foot of our material progress. We have, in effect, sterilized the sources of higher productivity which alone can create the abundance we seek.

This is written in no spirit of carping criticism but rather to indicate how completely the creative and productive functions have been trampled down during the stampede for fancied individual security. And as we have fled from the realities we have forgotten that, sooner or later, we must turn at bay and conquer unemployment and want with the natural weapons of new enterprise and plenty.

Of all these emergency expedients the engineer has been the particular victim, for in our economy it is his distinctive task to multiply the productivity of his fellow-man and, through his contriving of new products, new methods and new tools, to foster new enterprise.

Heretofore he has functioned chiefly as a hired man, a technical specialist, useful to answer the questions, "will it stand?" or "will it work?" but not so often called upon to advise "will it pay?" Too often engineers themselves, by their attitude toward their work, have lent color to the layman's notion that engineering and economics are things apart. This fact is, of course, that the presence of the dollar sign is what denotes an engineering problem as distinguished from one of applied science.

BUT if the engineer is to enjoy hereafter a more stable economic world in which to carry on, he must be prepared to help create it. Will his next generation be better equipped to stem a drift toward destructive inflation? Will they be competent to distinguish between sound expansion of productive capacity and the mere pyramiding of a financial structure? Will civil engineers be competent to help with tax reform and thereby foster sounder methods of financing public works? Will they be influential enough as individuals or as a group to make their weight count for sound industrial and public policies?

Their influence will grow out of individual character and group coordination but even these must sink their roots into the soil of self-confidence and public respect. And this in turn must be enriched by a training that will enable the engineer to appraise the economic soundness of public and private enterprise. In view of his special stake in economic stability and progress the engineer should be second to none in his appreciation and grasp of economic principle. Are we prepared to raise a new generation of engineers that will measure up to this responsibility?

Willard Chevalier

ENGINEERING NEWS-RECORD

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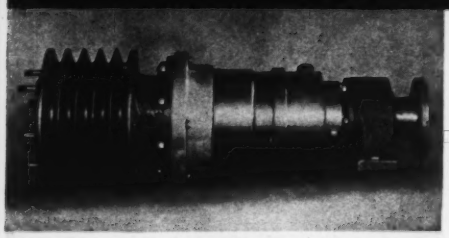

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In the News:

PRESIDENTIAL ANNOUNCEMENTS during the week removed some of the uncertainties and rumors that had grown up around the work-relief program. See the news pages for organization chart and latest facts regarding the $4,000,000,000 fund.

IF, says the National Association of Manufacturers, pending reform legislation were tabled by Congress, close to $20,000,000,000 would be spent by private industry for plant expansion or repair. Mentioned are the Wagner labor bill, legislation proposing unemployment insurance, the 30-hour week and the utility holding-company bill.

RESIDENTIAL CONSTRUCTION in March showed a gain of 130.9 per cent over the same month in 1934 for 770 identical cities, according to the Bureau of Labor statistics. Measured in dollars, new construction accounted for $20,350,706, and modernization for $17,786,448.

COMPLETION of a new addition to one sewage-treatment plant and start of work on another new plant were celebrated in Chicago this week. At the West Side plant a third battery of Imhoff tanks was put in operation; 36 tanks with a capacity of 204 m.g.d. are involved. The new Southwest Side plant will be of the activated-sludge type and will have a capacity of 400 m.g.d.

A COMMISSION to study the Central Valley project in California has been appointed by PWA Administrator Ickes. Members are Elwood Mead, Carl Farbach and David C. Coyle..

CENTRALIZATION of federal conservation activities in the Interior Department is the objective of a Senate bill introduced at the request of Secretary Ickes. To be known as the Department of Conservation and Works, the remade Interior Department would handle among other things the work of the PWA, the National Resources Board and the Oil Administration, according to the proposal.

In This Issue:

TIMED TO COINCIDE with the convention of the American Water Works Association, this Annual Waterworks Number is devoted to authoritative discussion of the water-service problem in its difficult present-day aspects.

IS THERE PROPER REALIZATION of the danger of exhausting present supply sources? Four instructive articles indicate the importance of the question and include discussion of the future of the Ohio River as a source, of the underground supplies of the Ohio Valley, and of the effect of the depression on water consumption generally.

WHAT HAS NEW EQUIPMENT CONTRIBUTED to improvement in water service? A group of articles cites experiences with elevated tanks and booster pumping stations, and describes new plant equipment that is aiding in providing more potable water at lower costs.

IS THERE WIDE APPRECIATION of the great new strides in water-purification practice? One article emphasizes the need for flexibility in design to accommodate future new developments. Another tells of Chicago's huge ammonia-chlorine plant, and a third describes new odor-control technique.

ARE WATER DEPARTMENTS AND COMPANIES meeting their special administrative problems? Articles on personnel, financing and broad policy formulation furnish food for useful thinking.

Follow the Construction of the World's Largest Earth Dam!

Next Week—A YEAR'S PROGRESS AT FORT PECK
May 23—DRIVING THE DIVERSION TUNNELS

BEHEMOTH, TAKE A BOW!

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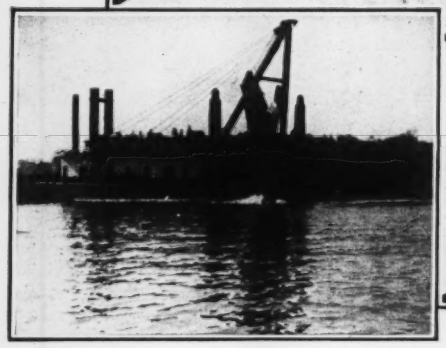

BEHOLD the "Big Bertha" of dipper dredges—the mightiest dredge ever to dip below the waters of the earth. Operating under 50 feet of water through the steel muscles of **American Steel & Wire Company Tiger Brand Wire Rope**—it loads a 1500 yard scow in practically two hours—and doesn't even work a "sweat" up about it. When it came to selecting the right wire rope to engineer this giant—naturally the owners of this largest Dipper Dredge in the world turned to the builders of the largest selling wire rope in the world—**Tiger Brand Wire Rope.** Wherever dredges dip, derricks swing and weights suspend, you'll find this safer—more dependable—more economical wire rope operating in the thick of things. Facts—and full cooperation—await your inquiry.

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ENGINEERING NEWS-RECORD

May 2, 1935

ANNUAL WATERWORKS NUMBER

AN EDITORIAL FOREWORD TO THIS ISSUE

THE water-service problem is one of a continually developing nature; it evolves in much the same fashion as does the community itself. Community growth causes quantity demands to tend steadily upward. Water resources become more and more highly prized for purposes of community supply. Rising consumer standards of water quality cause continual refinement of the definition of potability. Economic misadventure of the community itself occasions new problems. Vagaries of precipitation necessitate periodic reappraisal of the potentialities of supply sources that have long been used.

Although this characteristic of the water engineer's task has always been evident, it receives added significance in a time like the present, when economic, social, political and even physical factors of community life display such rapidity of flux. It is the function of this issue to discuss the dynamic nature of water service.

ADEQUACY of supply in view of changing circumstances of water source and quantity demands is given discussion through four articles. The first presents the Ohio River problem, which is that of maintaining the serviceability for water-supply purposes of a great river on which many collateral demands are made. Next are presented the facts in regard to the effect of the depression on the consumption of water and the rising trend that now prevails. A specific example of what happens when water demand overtakes the capacity of the supply, and an outline of the capacity characteristics of the underground water supplies of the Ohio River Valley region as determined by its geological and soil structure complete the section.

The second section comprises, first, a group of articles that relate, for four different cities, the improvements in service that can be attributed to the installation of elevated storage tanks and booster pumping stations, and, second a detailed account of the contributions that have been made by the manufacturers of waterworks materials and equipment to the solution of the water-service problem. Together the two articles portray accomplishment of a high order.

WATER purification displays probably more vitality than does any other phase of waterworks practice. Its progress as revealed in purification plants is discussed in the third section, dealing with flexibility in design to permit the plant operator to utilize the new purification methods; the huge new ammonia-chlorine plant built on one of Chicago's lake intakes; and the new technique that has been developed for odor determination.

The fourth section is devoted to the special problems of waterworks administration. Three phases of this subject are discussed: the proper limits to be set on efforts to economize, the selection and training of waterworks personnel, and the dangerous practice of using waterworks revenue to support other municipal activities.

Taken together, the articles in these four sections demonstrate the fact that the water-service problem in these times more than ever calls on the foresight, skill and diligence of waterworks men and on the understanding cooperation of the communities that they serve.

A Symposium on

THE EVOLUTION OF WATER SERVICE

- I -

WATER-SUPPLY SOURCES

H. W. STREETER — O. E. MEINZER
N. S. HILL, JR. — MELOY SMITH

- II -

WATER-SYSTEM OPERATION

D. H. MAXWELL — G. H. FENKELL
W. C. MABEE — JAMES D. DONOVAN
J. P. SCHWADA — THOMAS H. WIGGIN

- III -

WATER-PURIFICATION PROGRESS

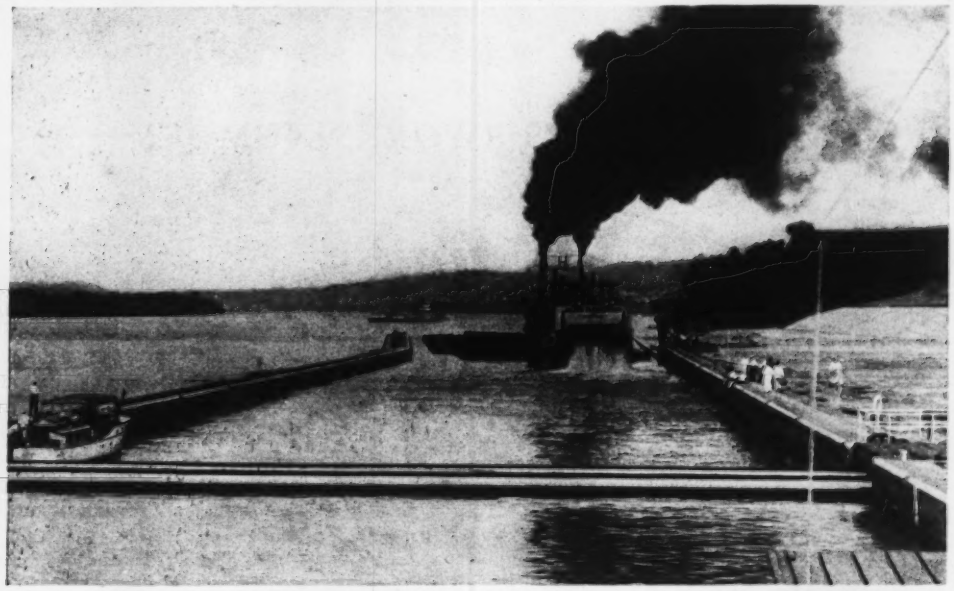
PAUL HANSEN — H. H. GERSTEIN
A. E. GORMAN — PAUL H. PETERMAN
M. W. COWLES

- IV -

WATERWORKS ADMINISTRATION

T. A. LEISEN — HARRY E. JORDAN
A. S. HIBBS — G. N. SCHOONMAKER
N. T. VEATCH, JR.

WATER-SUPPLY SOURCES



Wide World Photo

The Ohio River
Its Future as a Water-Supply Source

A navigable stream, receiving the drainage from a vast area and traversing six states, the Ohio River presents a difficult health problem—A statement of how collateral uses of a generous supply source modify the problem of using it for public water supply

BY H. W. STREETER
Sanitary Engineer,
U. S. Public Health Service,
Cincinnati, Ohio

THE essentially dynamic nature of the water-supply problem is nowhere better exemplified than in the basin of the Ohio River. This great stream is bordered by six states and drains portions of fourteen states comprising the most important industrial area of the country. In its 960 miles of length the Ohio serves not only as a source of water supply for many cities, towns and industries but also as the ultimate means of disposal for sewage and industrial wastes from the entire drainage area. Being navigable throughout its entire course, this river has become a major artery of commerce for bordering communities, particularly since its full canalization has been effected.

The drainage area of the Ohio, aggregating some 203,000 square miles, presents a widely diversified picture both in physiography and climate and in industrial and agricultural development. Its northeastern portion is largely industrial in character, being devoted to coal mining and steel manufacture centering around the Pittsburgh district. The northwestern section, though partly industrial, includes much agricultural territory, such as is found in the plains of western Ohio, Indiana and eastern Illinois. The entire southern portion, which includes most of Kentucky and Tennessee, is principally rural and except for a few cities is but sparsely settled.

The marked contrast between the density of population in these various sections of the drainage area has been shown in *Public Health Bulletin No. 143*, U. S. Public Health Service, 1924, a report of a comprehensive sanitary survey of the Ohio River Basin made in 1915-16. The extreme range noted at that time was from less than 50 people per square mile in the southern portion of the watershed to more than 600 per square mile in the area surrounding the Pittsburgh district. Although the total population of the watershed has increased since 1915 from about 15,400,000 to some 18,000,000, there probably has been little change in its relative distribution.

Corresponding roughly to this distribution of settlement and industry over the drainage area is the distribution along the main stream. Throughout the first 100 miles of river, extending from Pittsburgh to Wheeling, the settlement is practically continuous, with numerous iron and steel industries lining the banks. It is this section of the river which has given the name "the American Ruhr" to the Ohio River. Some 150 to 250 miles farther downstream,

extending from Pomeroy to Portsmouth, is another well-populated 100-mile section of the river, also highly industrialized. Below Portsmouth, at intervals of slightly over 100 miles each, are the large cities of Cincinnati and Louisville. From the latter city to the mouth, except for Evansville, the settlement along the river is relatively sparse and mostly rural, with tributaries draining a region of much the same general character.

The mean annual discharge of the Ohio at its mouth approximates 300,000 sec.-ft. The normal seasonal range is from 50,000 to 1,000,000 sec.-ft., roughly a twenty-fold variation. The recorded minimum flow has been as low as 10,000 sec.-ft. (during the 1930 drought period), and the maximum as high as 1,500,000. During normal years, extreme fluctuations of 40 ft. or more in river stage occur.

The construction of navigation dams throughout the river has converted it into a series of elongated pools during periods of low water. Most of these dams are of the bear-trap wicket type and do not function at higher river stages when open-channel flow conditions prevail. The effect of these dams is to retard the velocity of flow during pool stages, thereby promoting sedimentation and prolonging the times of flow of water from point to point. During higher stages the increased velocities of flow flush out the accumulated deposits, thus providing a self-cleansing action.

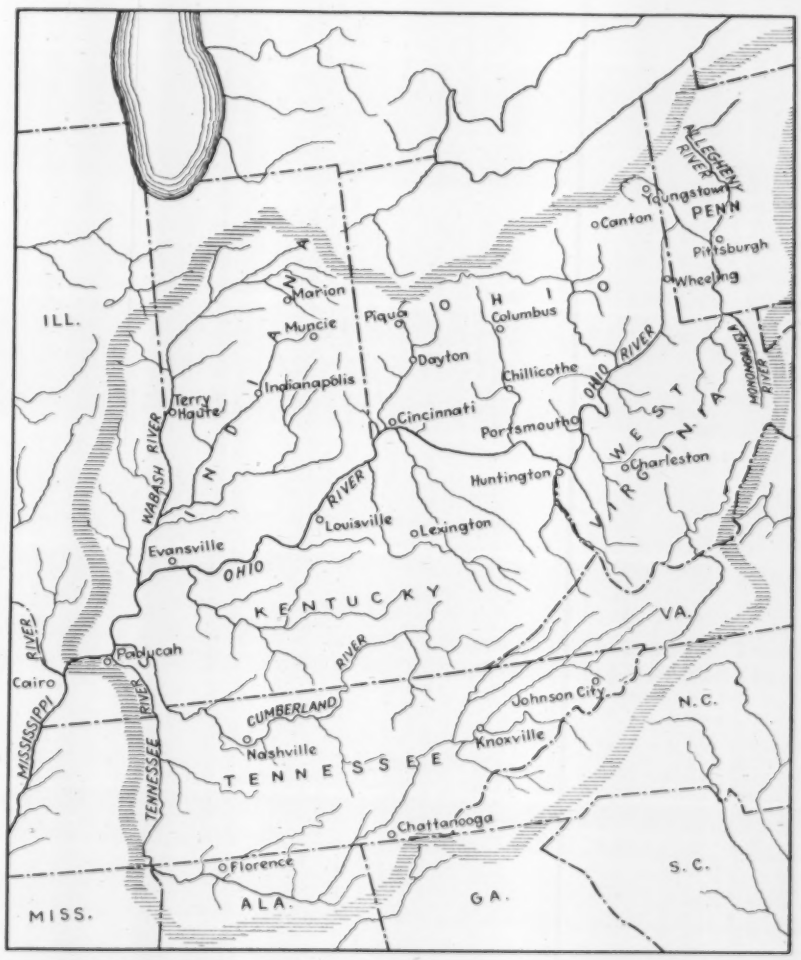
Growing pollution problems

The dual use of the Ohio River as a source of water supply and as a means of waste disposal has dated from the early days of settlement along the river. Up to the first decade of the present century, when the various cities began to install modern water-purification systems, public water supplies along the river were heavily polluted by sewage, and the death rates from typhoid fever consequently were very high. With the general advent of water filtration, supplemented later by chlorination, the prevalence of this water-borne disease declined rapidly, until at present it has almost reached a vanishing point.

During the past few years, however, growing difficulties have been experienced in obtaining water supplies of satisfactory quality from the river, particularly in the more highly polluted sections above Louisville. Among these have been: (1) the increasing content of sewage bacteria in raw waters at filtration-plant intakes, with wider degrees of variation and higher peaks during freshets; (2) tastes and odors in water supplies due to phenols, organic matter or microscopic organisms; (3) increasing prevalence of microscopic growths in the river during pool stages, adding to the difficulties involved in the efficient and economical operation of water filters; (4) excessive hardness and acidity of the river water during periods of low stage, causing boiler scale, corrosion of pipes and boilers and increased soap consumption. In addition, in recent years several widespread outbreaks of gastro-intestinal disorders have occurred in Ohio River cities, having every characteristic of water-borne ailments. The specific cause of these outbreaks has not thus far been defined, but they appear to be due to some organism or toxic substance capable of penetrating ordinary water-purification processes and not detectable by the usual laboratory tests.

Although these several difficulties doubtless have been influenced by a complexity of factors, they appear to be due largely to a progressive increase in sewered urban population, both along the main stream and on its tributaries, and to a concurrent increase in the discharge of mine drainage waters and certain other industrial wastes, notably those associated with the steel, coke and gas industries. Canalization of the river, though beneficial during periods of low water in promoting sedimentation and prolonging the times of natural purification, also has resulted in an increased scouring of deposited sewage matters during periods of freshets, thereby causing higher peak loads on water-purification systems at such times. In general, the effect of canalization of the river has been to improve conditions during low-water periods at the more distant points below major sources of pollution, but to move the denser pollution zones upstream closer to these sources.

Particularly serious conditions of pollution of the Ohio, in their effects on public water supplies, are found at present in the Pittsburgh-Wheeling and the Huntington-Portsmouth sections of the river. Between Pittsburgh and Wheeling the main source of difficulty is the excessive hardness and corrosiveness of the river water resulting from the presence of free acids and acid salts of iron and manganese, which interfere with effective purification of the water at times and yield effluents unsatisfactory in some respects for domestic or industrial use. Were it not for the bactericidal and coagulating effects of the acids and iron salts, this section of the river probably would be highly offensive



OHIO RIVER DRAINAGE BASIN. Its northeastern portion is largely industrial in character; industrial and agricultural development combine in the northwest; the southern part is mainly agricultural and is sparsely settled.

at low-river stages and would impose an excessive bacterial load on water-purification plants.

In the Huntington-Portsmouth section the cumulative effects of retarded sewage decomposition upstream, combined with heavy local pollution of the river, have made this zone of the river the most highly polluted bacterially of any stretch from which water supplies are taken. To produce water supplies safe for domestic use, all of the resources of modern water purification combined have had to be utilized, including double-stage coagulation, long periods of sedimentation, heavy chlorination and the use of activated carbon. All of the water-purification plants in this zone are now overburdened by excessive raw-water pollution.

Although the Cincinnati, Louisville and Evansville water-purification plants have not thus far experienced any degree of overburden comparable to that of plants farther upstream, they have been overloaded occasionally during recent years, not only from a bacterial standpoint but also from heavy growths of filter-clogging organisms in the river. The hardness of these water supplies has increased steadily, and on several occasions phenols have penetrated as far downstream as Louisville, with resulting taste and odor troubles, which apparently cannot be completely alleviated by water-purification methods.

If the present situation were to be summed up in a few words, it might be said that pollution of the entire upper half of the Ohio River system has brought about a progressive deterioration in the quality of water supplies as far downstream as Louisville, in spite of the application of every resource afforded by modern water purification. Although this deterioration has not thus far been serious below Portsmouth, the present margin of safety at cities like Cincinnati and Louisville is relatively narrow and appears to be growing smaller each year.

Urban pollution to increase

Looking to the future of the Ohio River as a source of public water supplies, it is desirable first to consider the trend of urban population growth along the river and in the watershed, as affecting the expected changes in the present status of pollution. Between the years 1915 and 1930, according to a recent estimate by Crohurst (*Public Health Bulletin No. 204*, U. S. Public Health Service, 1933), the urban population located directly on the river above Cincinnati increased 27.3 per cent and the rural population 2.3 per cent, the combined increase being 16.6 per cent. For the entire drainage area above Cincinnati, the urban population increased 36.7 per cent and the rural 4.1 per cent, the combined increase being 17.7 per cent. In 1915, 82 per cent of the urban population was sewered, and roughly 89 per cent of the sewage thus contributed was discharged without any treatment.

Making due allowance for some degree of anticipated reduction in the rate of urban population growth, it seems fairly safe to assume that from 1930 to 1945 the increase in urban population located directly on the Ohio River above Cincinnati should be not far from 20 or 25 per cent, and the corresponding increase in urban population on the drainage area should be fully 30 or 35 per cent. The resulting added pollutional effect on the Ohio River proper should fall somewhat between these two ranges, being shaped primarily by the increase in urban population located directly on the river but influenced to some extent by the corresponding increase along the main tributaries. Although this effect would be modified by any decided change in the proportion of the total urban population sewered, or in the degree to which sewage treatment might be extended, neither of these two factors appears to have undergone any material alteration since 1915.

With existing conditions of pollution in the upper section of the river and their all-too-apparent effects on the quality of public water supplies, it is entirely conceivable that a 25 or 30 per cent increase over the 1930 degree of pollution may bring about a critical situation in certain zones of the river, notably in the Huntington-Portsmouth stretch, where conditions have already passed the limit of safety. If the mine-sealing project recently instituted should result in eliminating any large proportion of the acidity from the Allegheny and Monongahela Rivers, the probable effect on the Ohio between Pittsburgh and Wheeling would be beneficial in so far as the reduction of hardness and corrosive properties of the water was concerned; but it would be otherwise with respect to sewage pollution, as the influences now tending to inhibit organic decomposition would be absent or greatly diminished.

The effects of further increased sewage pollution of the river likewise may be expected to intensify the growing difficulties being experienced at Cincinnati, Louisville and smaller cities in the middle and lower sections of the river in obtaining consistently safe and palatable water supplies for domestic use. These difficulties are now occasionally serious both at Cincinnati and Louisville, despite the fact that both of these municipal filtration plants have preliminary storage reservoirs in addition to complete rapid-sand filtration.

The hardness of Ohio River water during low stages of the river often exceeds limits that are now considered as desirable for domestic and boiler-water supplies. With the increase in the volume of mine-drainage and acid-iron waste waters discharged into the upper section of the drainage area, both the total and incrustant hardness of the river have shown a slight gain during recent years, though the greater part of its mineral content is derived from underground geological formations.

The development of flood-control reservoirs at the headwaters of the main tributaries of the Ohio, if it should be carried out on an extensive scale, doubtless would tend to ameliorate to some extent the present extremes of hardness in the river water by providing more balanced flows and especially by increasing low-stage flow of the river. The extension of the mine-sealing program also would have some degree of beneficial influence in this respect. Any excess of hardness remaining after these measures have been made effective could be removed only through water-softening operations in connection with individual purification systems. Should public demand for softer water become sufficiently insistent, the extension of existing purification plants along the river to include water softening is likely to be undertaken, regardless of the outcome of the flood control and mine-sealing programs, as it is doubtful whether the complete institution of these projects would insure at all times water supplies of satisfactorily low hardness, consistent with the advancing public standards in this respect.

An improvement program

From a technical standpoint, efforts to restore the safety, palatability and suitability for domestic use of water supplies taken from the Ohio River probably will be desirable along the following broad lines:

1. A general program of sewage treatment along the Ohio and its major tributaries, designed to hold both the average and maximum degrees of pollution of the river at the various water intakes within a safe limit for effective purification.

2. Extension of mine-sealing so as to eliminate as far as practicable acid mine drainage waters from the tributaries of the Ohio.

3. Further efforts toward the elimination of acid-forming, taste-producing and other industrial wastes harmful to water supplies from the river and its main tributaries.

4. Development of flood-control projects that will tend to stabilize flow conditions in the Ohio and especially to provide more dilution water during periods of extremely low river stages.

5. Extension of existing water-purification plants so as to provide ample preliminary storage, where feasible, and to include facilities for water-softening operations during periods of excessive hardness in the river water. In all other respects, water-purification systems along the Ohio now appear to have been developed practically to their highest possible degree of elaboration and general efficiency.

In any program of remedial measures, it should be recognized that it would be

both unnecessary and practically impossible to attempt any full restoration of this river to its original state of pristine cleanliness. If all of the sewage and industrial wastes were removed from the river, the drainage water from rural and agricultural areas would still constitute a major source of pollution, requiring purification of water supplies by essentially the same methods as are now followed. Probably the most reasonable criterion of limiting pollution would be the maximum capacity of efficient water-purification systems, both as to producing hygienically safe effluents and removing chemical substances rendering water impalatable or generally unsuitable for domestic use.

Before concluding this article, it is desirable to consider very briefly some of the administrative and legal aspects of the problems which may be involved in undertaking any comprehensive program of remedial measures such as that above described.

Up to the present time the only concerted action thus far taken by the states bordering the Ohio River toward ameliorating the damage to public water supplies resulting from virtually unrestricted pollution of this river system has been the formation of an Ohio River Board of State Sanitary Engineers, organized several years ago through the initiative of the Surgeon General of the U. S. Public Health Service, for the immediate purpose of curbing the discharge of phenol-bearing wastes into the river by coke-byproduct manufacturing plants. The results attained in this respect have been very encouraging, as complaints of chlorophenol tastes in water supplies taken from the river have been considerably diminished during the past ten years and have resulted largely from the occasional leakage of these wastes through the recovery processes installed for stream protection. An effective notification system has been established by this board, whereby operators of downstream filtration plants are forewarned when these upstream spills occur.

The more recent functions of this cooperative board have been very largely those of coordinating regulations and administrative policies of the states bordering the Ohio River with respect to pollution of the river and its tributaries. No interstate compacts have thus far been negotiated or put into effect, nor has any definite action been taken by these states with respect to a general and systematic program of stream sanitation for the Ohio River system as a whole. The chief value of the board's activities to date has been in the interchange of information and in mutual cooperation when more acute situations of common interest arise, such as that of phenol pollution.

The chief difficulty faced by interstate boards of this character, in so far as the application of comprehensive remedial measures of stream sanitation is concerned, is that any voluntary treaty or formal agreement of joint action must be ratified by several state legislatures before it can become legally effective. Along the Ohio River this difficulty has been enhanced by the fact that in at least one state bordering the river specific exception is made of the applicability of existing stream-pollution control laws and regulations to this particular river, because of its being an interstate stream.

The size and importance of the Ohio River and its vital relation to the industry of the country at large would seem to make it imperative that no effort be spared to remedy the present insanitary condition of this waterway, which has jeopardized the safety and wholesomeness of the domestic water supplies of riparian dwellers, and to some extent has damaged the river for commerce, recreation and industrial uses. The principal obstacles now standing in the way of an intelligent and comprehensive program of river sanitation in this drainage area appear to be legal and administrative, as the necessary engineering data are fairly complete and well established, mainly through studies made during recent years by the U. S. Public Health Service. The institution of such a program should not be long delayed, as the present trend of population and industrial development presages more critical conditions in the near future unless they can be effectively curbed. The remedy lies in the hands of the several states bordering the river, in cooperation with the federal government, which also has a rightful interest in the broader interstate aspects of the problem. The more narrow local and commercial interests involved in this problem must, however, give way to the common good of all and place themselves solidly behind these governmental agencies before any real progress can be made toward its permanent solution.

AT CINCINNATI, this year's meeting place of the American Waterworks Association, the limit of the Ohio's usefulness as a water-supply source is being approached as a consequence of industrial and sewage pollution.

Water Consumption Rises Many Supplies Require Expansion

Records of a large number of communities show that consumption of water has been rising steadily since 1933 in all sections of the country—Numerous communities found to need additions to their sources of supply

BY NICHOLAS S. HILL, JR.,
Consulting Engineer, New York, N. Y.

THE BUSINESS of the water utilities reached high levels in the era of prosperity preceding 1930 and then dropped to points lower than could have been anticipated by the most pessimistic of waterworks operators. In 1933 the rapid decline slackened, their business fluctuated during the year with the confused trends of general business activity and then definitely turned upward.

The variations in water consumption in the average community are closely allied to local industrial activity and economic conditions. Domestic water consumption may be affected by the practice of unusual economy by consumers whose financial resources and earning capacity have been stricken, but water is a necessity and its cost is so low that the effect of a business depression on domestic use is usually not of great significance beyond the halting of the normal increase. The industrial demand, however, fluctuates in harmony with the industrial activity of the community. With the factory closed, little or no water is used and the revenue from that source ceases or becomes negligible in amount. In a community where 35 or 40 per cent of the total consumption is industrial, the slackening of industrial activity seriously affects the operations of the water utility.

Water utility operators are fully cognizant of conditions in the areas served by them, are able to evaluate the effect of local industrial activity on their business and to speculate on the future trends. The purpose of this paper is to attempt to bring these local trends into focus and present a cross-section of the United States as a whole.

To this end, data have been assembled from published reports and private correspondence of more than 100 of the larger cities of the country, covering the period between 1925 and 1934. These have been carefully analyzed and to a certain extent culled to eliminate doubtful material, to produce as representative a picture as possible from a geographical standpoint and to stress particularly the industrial aspects. In preparing averages for the various sections of the United States, the data were weighted in accordance with the amount of water produced. In order to prevent distortion of the curves, the largest cities of the country have been eliminated, as in several instances special conditions prevailing indicated considerable divergence from general trends, and their magnitude was generally so great that they assumed too great weight in the composite data.

The results have been summarized in the form of yearly indices based on the year 1926 as 100. Fig. 1 shows the total water production, the industrial consumption and other use, the last item including domestic consumption and unaccounted-for water. It can be seen that growth during the first four years was more or less normal, then shot steeply upward in 1929, with both domestic and industrial use following the same trend. For the country as a whole, the water consumption remained relatively stable in 1930, but fell sharply thereafter and reached its lowest point in 1933. It is interesting to note that in 1933, when the industrial consumption was only 77½ per cent of 1926, domestic consumption and unaccounted-for water were about the same as in 1926. Increasing business activity in 1934 caused a sharp rebound, bringing the total consumption to a point above that of 1926 and to about the 1927 level.

If we compare the curves with graphs of general business, it is evident that the water-consumption index lags about one year behind the more sensitive barometers such as the Federal Reserve Board's index of industrial production, and, most important, it is not subject to such violent fluctuations. From the standpoint of water production, the water industry may be considered relatively stable. While it did not share fully in the upswing, neither did it plumb the depths of the depression. Although a ten per cent change in volume of business may mean the difference between profits and no profits, in a well-managed company this should not be disastrous.

Fig. 2 shows the total water consumption for certain sections of the country. It would appear that the Middle Atlantic states had the smallest share in the era of prosperity and felt first and received the worst blows of the depression. All sections have shared in the sharp 1934 upturn, while the Southern states show a similar benefit in 1933. Only the Middle Atlantic states remain well below the 1926 level. In spite of the 1934 increase, their water-production index is below the lowest figures reached during the depression by any other section of the country. On the other hand, the reduction in total consumption from the 1929 and 1930 peaks is quite uniform in all sections, and were the year 1929 to be used as a basis of comparison the decline and recent upturn would show great similarity in all sections.

An attempt to predict the probable immediate future trend would be foolhardy. In the past, engineers have relied upon past records supplemented by study and attempted evaluation of local factors to produce curves that appeared reasonable. It is to be hoped that their predictions will appear more reasonable a few years hence than they do today. Among the cities canvassed a considerable number reported studies made prior to 1925, which, when averaged, showed a predicted water consumption for the year 1935 about 45 per cent above the actual 1926 use. The actual 1934 production, however, was only 1½ per cent above the 1926 figure. It is apparent, on the other hand, considering the relative stability of the domestic usage, that a continued business advancement would alter the waterworks picture materially. The 1934 trend of increase in industrial water consumption, if continued for two years, would bring business up to the 1929 level. While it may not be believed that this will eventuate, still the waterworks operator may well consider the possibility as it affects his property.

Yield of supply sources

Information on the developed yield of the supply sources of the communities investigated was also requested. From the data obtained and from other sources, an attempt was made to determine and fix the limit of capacity of each supply, regardless of whether it occurred in the collecting works, the purification system or the pumping system.

A comparison of the developed capacities with the actual 1934 water requirements would be of little significance. A water utility must be developed to meet the maximum demand, including fire

draft, which may be made upon it. The variations in demand and method of meeting them are individual problems in each community.

The primary factor is the amount of available storage on the system. Where such storage is negligible, the supply works are called upon to meet every fluctuation in load and must be designed accordingly. As the available storage is increased, the capacity of the component parts of the supply works may be reduced.

As an example, in a city where the average annual daily consumption is 15 million gallons, varying as follows,

Maximum month	16.5 m.g.d.
Maximum week	18.7 m.g.d.
Maximum day	21.0 m.g.d.
Maximum hour	30.0 m.g.d.

the draft on the supply works may be limited to the maximum daily rate (21 m.g.d.) if available distribution storage of 2.1 m.g. exists and is fully utilized. Similarly, if 4.5 m.g. of available storage is utilized, the draft may be reduced to that of the maximum week (18.7 m.g.d.). And if 21 m.g. is utilized, the draft may be reduced to the maximum monthly rate (16.5 m.g.d.). Storage capacities here stated are those actually used in reducing the peak demands on supply works. Additional storage is necessary to provide for fire draft, unusually heavy peaks and stand-by reserve against service interruptions. The quantity necessary for stand-by service and the limit of storage depletion as affecting pressure gradients are peculiar to each utility and must be studied individually.

The extent to which a supply works should be developed is dependent largely upon the seasonal variations in demand, the amount of distribution storage available and reasonable provision for future growth. In order to investigate the adequacy of existing supply works, it is necessary to take account of this interrelationship. As a first step, the water utilities were grouped with regard to the relation of capacity to seasonal, daily and hourly fluctuations in demand as follows:

GROUP	Per Cent of Communities
Communities where developed safe yield is equal to or less than:	
Average annual daily demand...	3
Average demand during maximum month, but greater than average annual daily demand ...	7
Average demand during maximum day, but greater than average rate during maximum month.	31
Average demand during maximum hour, but greater than average rate during maximum day	34
Communities where developed safe yield exceeds average demand during maximum hour	25

In 3 per cent of the communities canvassed the safe yield during an extreme dry period is estimated at less than the 1934 average annual daily rate. These cities are in a precarious position.

The second group, having developed capacities equal to the maximum month, or somewhat less, totals 7 per cent of the cities investigated. All the cities in this group require development of additional collecting works or purification and pumping improvements, to enable them to meet the immediate future demands, except one, which by reason of very large available storage, may not require immediate construction but will if there is any material increase in water demand.

The third group, including those utilities developed to points between the maximum monthly and maximum daily rates, and aggregating about 31 per cent of the total, is more difficult to interpret without complete knowledge of each system. It is probable, however, that with any material increase in industrial activity, at least one-half of

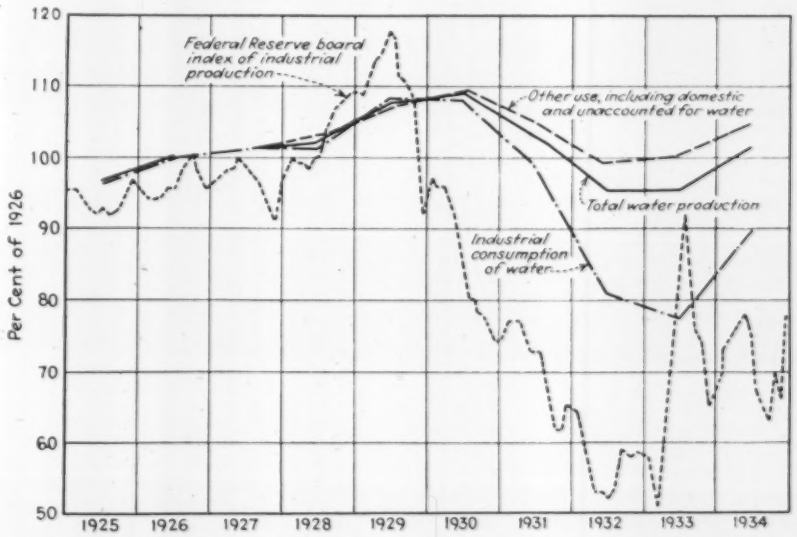


FIG. 1—TREND OF WATER CONSUMPTION in the United States, 1925 to 1934. Total consumption lags about a year behind the sensitive index of industrial production.

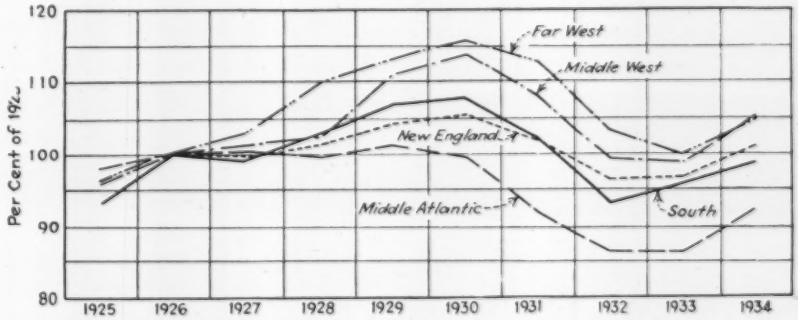


FIG 2—THE RISING TREND OF CONSUMPTION is characteristic of all sections of the country.

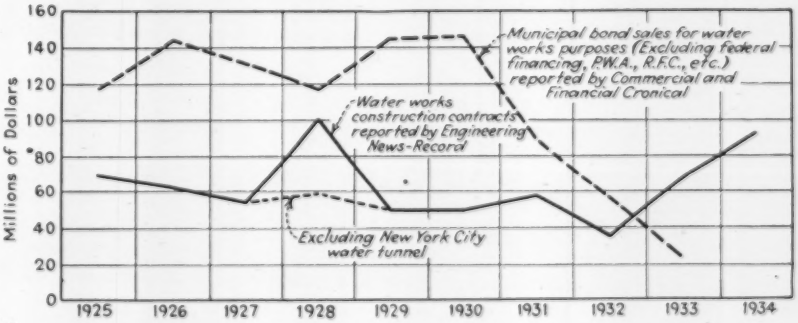


FIG. 3—WATERWORKS CONSTRUCTION CONTRACTS and municipal bond sales for waterworks purposes.

these communities will require additional construction to provide a safe margin above requirements and surplus.

The last two groups, aggregating 59 per cent of the total, probably include a number of systems where peculiar local conditions will require new construction in the near future.

Considering the waterworks systems included in this study, it appears that about 25 per cent of them require additions to their sources of supply to meet the probable demands made upon them if the present gains in water consumption hold and continue to advance even moderately. The construction requirements indicated are only those concerned with the adequacy of supply. Nothing is revealed in regard to necessary improvements in the distribution system, required replacement or rehabilitation of equipment, deferred maintenance, or construction designed to enhance the potability and appearance of the water furnished to consumers.

The data presented are believed to be fairly representative of the class of cities selected. The problems of the smaller communities differ somewhat, and an attempt to apply the conclusions to the much greater number of smaller utilities might be misleading. However, a considerable volume of desirable or needed extensions of supply works is evidenced and, taking all factors into account, there appears to be a substantial amount of construction that might go ahead if conditions were favorable.

Difficulties of financing

A demonstration of the desirability of additions to a waterworks system is not always sufficient to cause their immediate construction. Both privately owned companies and municipalities must be able to finance the work. Private companies with reduced earnings have found financing difficult, but it is hoped that with the upward trend and improved bond-market conditions this difficulty will be removed. Taxpayers today are not disposed to vote large bond issues, no matter how desirable the improvement, unless it is to secure for their community a considerable share of federal or state funds to promote construction activity and provide work relief.

During 1934 more than 800 waterworks projects were authorized and financed through the PWA. Many other additions and improvements were carried on under the CWA, FERA and TERA. Fig. 3 shows the volume of contracts reported by *Engineering News-Record* for the last ten years and also the municipal bond sales for waterworks purposes as reported by the *Commercial and Financial Chronicle*. The 1928 peak in the curve of contracts awarded is caused by one large contract of $42,000,000 for a water tunnel in New York City. Eliminating this abnormal item, the curve shows a downward trend from 1925 to 1929 and an upward trend subsequently. The rapid increase in 1934 shows strikingly the stimulus given to waterworks construction by government loans and grants. The bond-sales curve drops precipitously after 1930. The complete data for 1934 are not yet available, but with improved market and low interest rates the curve moved upward in that year. No financing under the RFC or PWA is included in this record, and the curve indicates that the great bulk of the recent construction has been done with federal aid. Construction through private corporate financing during 1934 was negligible.

Another $4,880,000,000 has been appropriated by Congress for work relief and to increase employment by providing for useful projects. Of this, $900,000,000 is scheduled for state, county and municipal public works. A considerable portion will go into waterworks improvements. Many that are badly needed will be undertaken, and also, in all probability, many that may not be warranted economically. To the extent to which the government is willing to finance new work the activity in the waterworks field should increase during the next few years.

Emergency Measures Defer Approaching Water Shortage

Rochester's upland supply faced with depletion as a result of subnormal rainfall —To avoid water famine temporarily, the city arranged to purchase surplus water from a large industry and from a private utility serving part of the city and rearranged the conduit system to allow drawing on the lower levels of the lakes

BY MELOY SMITH

Superintendent of Water, Rochester, N. Y.

IT WAS just a year ago that it became evident that the consequence of several years of deficient precipitation was going to be a serious depletion at an early date of the upland water supply of Rochester, N. Y. While it could be seen that an actual water shortage was not likely to occur before the end of 1934, it appeared essential to supplement the supply immediately if shortage during 1935 were to be averted. The steps taken in the emergency form the subject matter of this article. They include the purchase of the surplus water produced by the private water system of the city's largest industry, the purchase of an additional large amount from a private water company that ordinarily supplies part of the city, and the modification of the conduit system that brings water to the city so that a greater share of the reservoir contents could be drawn on.

Rochester's water-supply system

The normal water-supply system of Rochester is three-fold. The principal domestic supply comes from the Hemlock-Canadice watershed. In addition, the central business portion of the city is served by a high-pressure fire system which, in recent years, has been pumping Hemlock water through its mains. Portions of five wards, as well as most of the towns contiguous to Rochester, are served by the Rochester & Lake Ontario Water Service Corp., a subsidiary of the Federal Water Service Corp.

Hemlock Lake is a glacial lake 7 miles long and ½ mile wide, with a drainage area of 48 square miles. It lies between high hills 30 miles to the south of the city and almost 400 ft. above it. Water from this lake was first made available in 1876. Since then, the storage capacity of the lake has been increased by the construction of a dike, which is now at such a height that the maximum capacity of the watershed over a period of years has been utilized.

Canadice Lake, a smaller reservoir, lies in a valley parallel to Hemlock Lake, 2 miles to the east and 200 ft. higher. It was added to the system in 1919. This

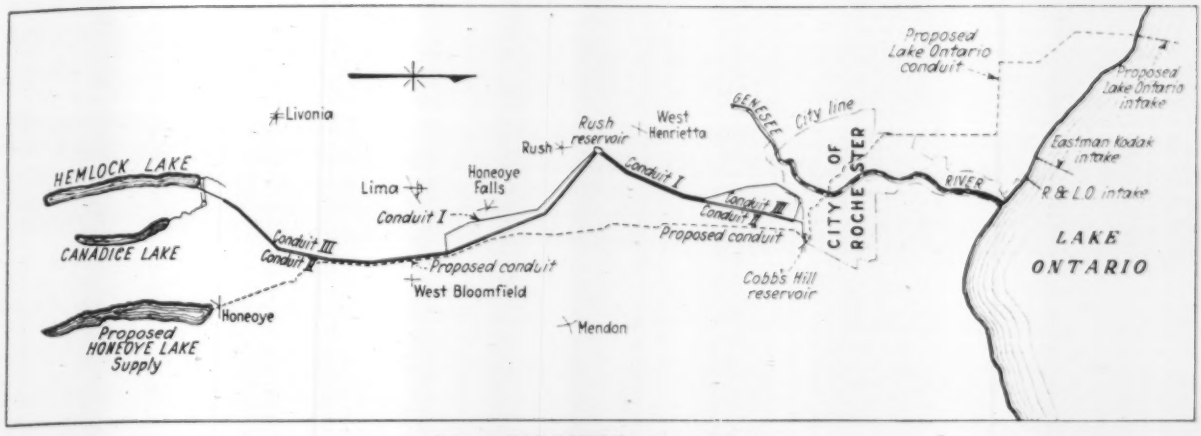


FIG. 1—ROCHESTER'S water supply is drawn principally from two lakes about 30 miles south of the city. Because of the limited capacity of this source after several years of deficient rainfall, an additional supply must be provided, for which two alternate plans have been proposed. One would draw water from Lake Ontario; the other would develop another upland lake.

lake is about 3 miles long, ¼ mile wide and has a drainage area of 12 square miles. The stream into which the lake empties, about 4 miles in length, is led into Hemlock Lake and drains an additional area of about 6 square miles.

Because of its larger storage capacity, it is the general operating practice to use Hemlock as the storage and impounding reservoir.

From these two lakes there are three gravity conduits by which the water is brought to the city:

Conduit I was built in 1873-1875; the upper end consists of 1,000 ft. of 36-in. wrought-iron intake pipe and 10 miles of 36-in. riveted wrought-iron pipe with cast-iron bells. The lower portion is composed of 24-in. cast iron.

Conduit II was completed in 1894 and consists of 2¼ miles of brick-lined masonry tunnel of a horse-shoe shape, 6 ft. wide and 6 ft. high, discharging into a 38-in. riveted-steel pipe.

Conduit III starts at the end of the brick tunnel. It was completed in 1918 and consists of about 8 miles of 37-in. cast-iron pipe, and the remainder is of lock-bar steel.

The Holly or fire-pressure system is a separate system of mains which serves the central commercial and industrial district and a considerable outside area, including manufacturing and minor mercantile districts. Supply is by continuous direct pumping from either, or both, of two pumping stations. The normal pressure maintained is 90 lb. per sq.in., which is raised to 125 lb. per sq.in. during fires. The consumption of the system averages about 500,000 gal. per day. Because of its age and because a large portion of the pipe is laid on rock, this system requires constant maintenance and inspection in order that leakage may be confined to reasonable limits.

Early in May of 1934 it became apparent that the lakes were not going to fill up and that the estimated safe yield of 30 m.g.d. from the Hemlock-Canadice watershed was too high. Therefore, several changes in operating procedure of the system were put into effect, and several additions were made to the plant.

The first step to conserve the water was to reintroduce Genesee River water into the Holly system, which was done on May 8, 1934. Genesee River water is not clean, however, and the effects on the distribution system and the pumping machinery are far from desirable. Although additional screens have been installed in the system, the wear on the pump impellers is noticeable.

Newspaper advertisements and public announcements requesting the public to stop lawn-sprinkling were put into effect early in the summer. The people of the city responded so well that a considerable load was taken off the system of the private water company as well as off the city system, a result that was not at all desired by the company.

The repair department of the waterworks early in the year started an intensive distribution-system survey and discovered several large leaks, which were promptly repaired. The most gratifying part of this work was the result obtained from the survey of consumers' services. Upon the discovery of a leak the property owner was notified by postcard that the leak should be properly repaired, and in almost every instance this was done on the first notification.

The annual pitometer survey was continued, and the recurrence of leakage discovered was found to be small, proving to this department that this method is of great value in keeping leakage at a minimum.

Kodak water purchased

The Eastman Kodak Co., whose principal plant, Kodak Park, is located in the northwestern part of the city, had its own water plant. There is an intake and pumping station on the shore of Lake Ontario, and there are two cast-iron force mains connecting the pumping station with the Kodak Park plant. Their water, which is used primarily for manufacturing processes and fire protection, is filtered through slow sand filters and is not treated in any other way.

Through cooperation with the Kodak officials and the State Water Power and Control Commission, the city obtained permission to use as much as 4 m.g.d. of Kodak water when and if the Kodak Co. could spare it, for the period of the emergency. A 30x20-in. wet connection was made with the company's 30-in. force main at a point where the Kodak water is under a very small head. The 20-in. pipe is reduced to 16-in. and carried into a 17,000-gal. covered steel tank. The flow of the water into this tank is regulated by a float-actuated butterfly valve. The Kodak water is sterilized in the tank by the ammonia-chlorine process, and then pumped against the head of the Hemlock system by a 4-m.g.d. pump. Nearly 1,500 ft. of 16-in. cast-iron main was laid in Dewey Ave., to connect this plant with the city distribution system.

The ordinance authorizing this work was passed by the city council on June 25, 1934. The plant was built entirely by regular waterworks employees, and water was turned on and the plant put into operation late in August.

The Eastman Kodak Co. has furnished the site for the pumping station rent free, and is selling the water to the city at cost, which averages something less than 4c. per thousand gallons. The cost of repumping and treating the water has averaged about 1½c. per thousand gallons, with no allowance for the amortization of the plant. The plan has been used to capacity since its completion.

Conduit system modified

It has long been the desire of the Rochester waterworks to abandon the Hemlock Lake end of Conduit I because of its elevation. It is possible to draw from a much lower lake level with the intake that serves Conduits II and III. Hence, during seasons of low storage and large consumption there was great danger of exposing and collapsing the intake. Also, the upper end of Conduit I, consisting of 50,799 ft. of 36-in. wrought-iron pipe, ⅜-in. thick, had out-

FIG. 2—CROSS-OVER CONNECTION of 24-in. spiral-welded iron pipe between Conduits I and II, to allow the lower levels of Hemlock Lake to be drawn upon safely.

lived its usefulness, and considerable difficulty has been encountered in making repairs when leaks occurred.

The plan adopted to eliminate the difficulty of the high intake of Conduit I was to construct a cross-over between Conduits I and III at a point about 11 miles north of Hemlock Lake. At this location the two conduits are about 4,100 ft. apart, and the hydraulic grade of Conduit I is lower than that of Conduit III, thereby obviating the necessity of pumping and eliminating all of the 36-in. wrought-iron pipe.

The new cross-over consists of 24-in. (inside diameter) spiral-welded iron pipe, which is coated and lined with bituminastic enamel. Most of the pipe sections were in 40-ft. lengths. A few shorter pieces were used to conform to the contour of the land. Bolted sleeve couplings were used for the straight pipe.

Construction was started on Aug. 20, and water was turned on Oct. 10. As in the case of the Kodak pumping station, all the work was done by employees of the waterworks department. This project was designed by and constructed under the supervision of A. P. Mussi, waterworks engineer.

The cast-iron portion of Conduit I is still in excellent condition, and when broken into at the time the connection was made, the interior was found to be free from tubercles or encrustations.

Water purchased from utility

The last emergency measure taken was the construction of a 16-in. connection between a main of the Rochester & Lake Ontario Water Service Corp. and the Cobbs Hill distributing reservoir of the city system. About 1 m.g.d. has been taken from this source. The company's water is delivered into the city reservoir at a cost of 7.8c. per thousand gallons.

Although these measures were adequate in the emergency to avert an imminent shortage it was evident that they were only capable of giving temporary relief and that the situation called for an additional supply of water. A non-partisan committee after several months of study recommended two alternate plans for a permanent additional supply: A modification of the upland water plan (Honeoye Lake) recommended in the Hazen-Eddy-Fisher report of 1927, or the construction of a pumping plant on Lake Ontario at a point 8½ miles west of the outlet of the Genesee River.

Because of the lower initial cost of the latter plan, it was adopted by the public works and engineering committee of the city council, and the council authorized the city manager to petition the State Water Power and Control Commission for authority to construct a 10-m.g.d. plant using Lake Ontario water.

Considerable political opposition to this plan has developed, however, and to date the answer to Rochester's need for a permanent additional water supply is either "in the laps of the gods" or in the hands of the politicians.

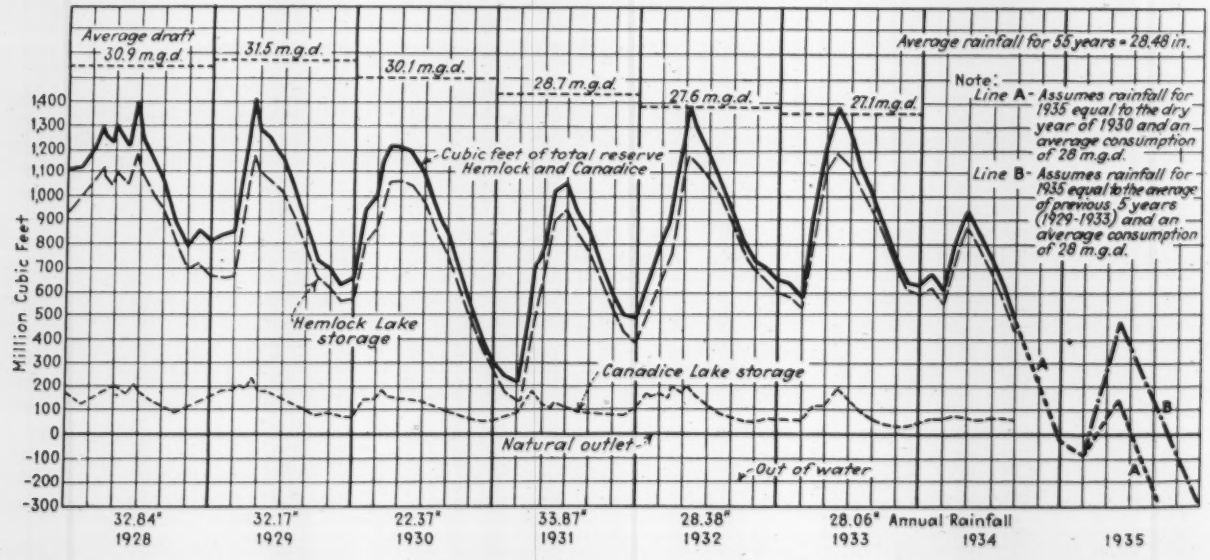


FIG. 3—STORED CONTENTS of Hemlock and Canadice Lakes, from 1928 to 1934. Reserve supply in May, 1934, was abnormally low, due to deficient rainfall, and it was recognized that a badly depleted supply was not far in the future.

Ohio Valley Well Supplies Subject to Slow Reduction of Capacity

The safe yield of a multitude of small water systems in the Ohio drainage basin that draw on subsurface storage is limited by the underground basin's extent, the rate of recharge and the permeability of the subsurface materials—Many well systems are approaching depletion from long-continued overdraft pumping

BY O. E. MEINZER

Geologist in Charge, Division of Groundwater, U. S. Geological Survey, Washington, D. C.

THERE ARE in the drainage basin of the Ohio River probably between 700 and 800 public waterworks supplied from wells. The communities served range in size from Dayton, Ohio, with more than 200,000 inhabitants, to villages of less than 1,000 population. To water-supply engineers perhaps the most outstanding characteristic of these waterworks is the great variety in the sources of their underground supply. From place to place the wells differ widely in their depths, the rocks that they penetrate, the quantity of water that they produce, and the chemical character of that water. The variation is not altogether haphazard, of course, but is determined by the stratigraphy and structure of the underlying terrain, which has been studied and mapped in considerable detail in nearly all parts of the region through the cooperative effort of many geologists during the last hundred years.

Nearly the entire Ohio River Basin is underlain by rocks of Paleozoic age. These consist of a great succession of sedimentary strata (chiefly sandstone, shale, and limestone) a good many thousands of feet in aggregate thickness. They have been divided, somewhat arbitrarily, into five rock systems—the Cambrian, Ordovician, Silurian, Devonian and Carboniferous. In most of the basin these strata lie nearly horizontal but dip enough to bring successive beds to the surface from place to place, so that at one town water-bearing sandstone or limestone may be at the surface, while at the next town the surface rock may be an unproductive shale. Virtually the entire stratigraphic succession, from the lower part of the Cambrian to the upper part of the Carboniferous, appears at the surface at some place in the Ohio River Basin.

There is one characteristic of all these Paleozoic rocks throughout practically all of the Ohio River Basin which greatly diminishes their value for water supply—namely, that they contain potable water only in the upper few hundred feet, and at greater depths they contain only salty water unfit for use. This is not equally true of the Paleozoic rocks farther west, for in Wisconsin, Illinois, Minnesota, Iowa and Missouri many of the public supplies are derived from deep wells in the Paleozoic strata.

In the northern part of the Ohio River Basin the Paleozoic rocks are covered with glacial drift, including great quantities of sand and gravel washed out from the ancient glaciers and deposited in the valleys of the Ohio River and its northern tributaries and also in ancient buried river courses not now occupied by rivers. The most productive sources of groundwater in the entire basin are these glacial deposits, especially the deposits of outwash sand and gravel. Hence, in the part of the basin north of the Ohio River and along the river itself there are numerous cities of considerable size that have waterworks supplied from wells, but elsewhere in the part of the basin south of the river only the smaller towns as a rule utilize wells for public supplies.

Everyone connected with waterworks affairs knows that in the aggregate a

FIG. 1—PALEOZOIC ROCKS cover a large portion of the northeastern part of the country. They include numerous water-bearing sandstones and limestones interbedded with shales that are generally unproductive or yield only small quantities of water.

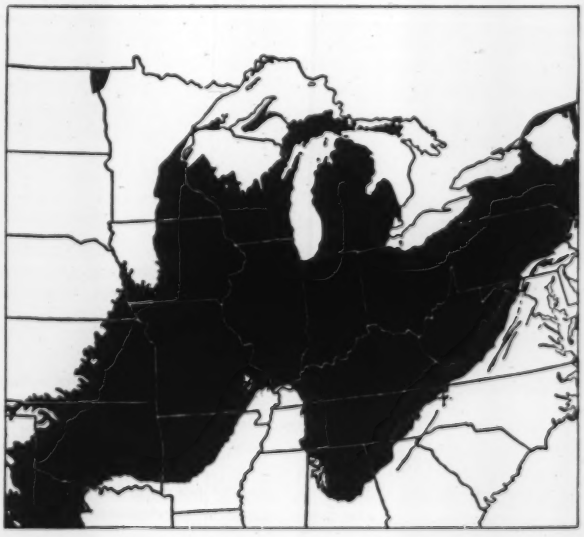
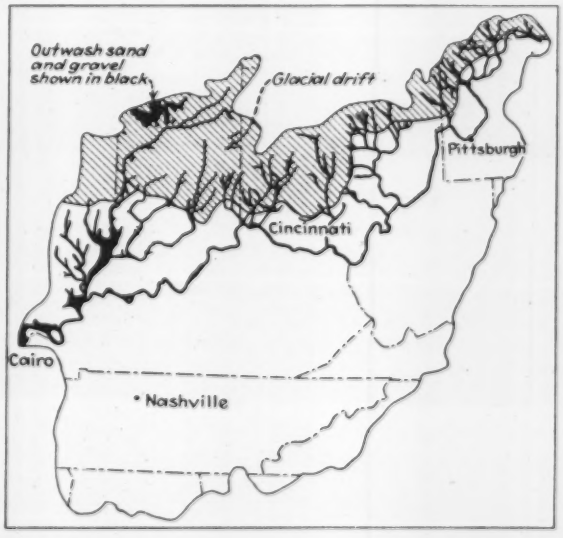


FIG. 2—GLACIAL DRIFT covers much of the northern part of the Ohio basin. The most productive sources of groundwater in the entire basin are in these glacial deposits, especially the deposits of outwash sand and gravel.



great deal of trouble is experienced with public supplies derived from wells. There appear to be two principal reasons for this trouble.

In the first place, the well-water supplies have the inevitable disadvantage of the small town waterworks in being constructed and operated with relatively little engineering service. Thus, in 1930 there were in the state of Ohio 268 public water-supply systems that derived their water entirely from wells, and these systems served 1,235,000 people. In contrast, there were 91 systems that derived their water entirely from surface streams or lakes and served 3,105,000 people. Thus, the average well-water system in Ohio serves not quite 5,000 people, whereas the average surface-water system serves nearly 35,000 people. In the region south of the Ohio River the contrast in size is still greater.

In the second place, the well-water supplies have the disadvantage that as a rule neither the consulting nor the operating engineers are specialists in groundwater hydrology, and only rarely is advice obtained from a geologist who is a competent specialist in this highly technical subject. As a matter of fact, most groundwater developments have been more or less haphazard, and questions of permanency of the groundwater supplies and of available means for improving them have been answered largely by random conjecture rather than by the application of sound technical methods.

Groundwater quality

Many of the groundwater supplies are unsatisfactory because of the hardness or high iron content of the water. Some of the larger communities have found a solution of this problem by replacing their wells with properly treated surface supplies. Other communities may find it advisable to make this change, perhaps keeping their wells for a reserve supply or utilizing the groundwater for special purposes, such as for use in cooling plants. Many of the mineralized groundwater supplies can, however, be made quite acceptable or can at least be greatly improved by utilizing modern methods of softening and iron removal. This method of improving the quality of the water is available to many communities where the installation of surface water supplies would be undesirable, impracticable or prohibitive in cost.

Wherever salty water underlies fresh groundwater, there is a possibility that the salty water will be drawn up by the lowering of the head in the fresh water that results from heavy pumping. If a perfectly watertight bed separates the fresh water from the underlying salty water, there can be no contamination of the fresh water except through leaky wells or other excavations that extend to the salty water. However, few beds are so impermeable, continuous and unbroken that they will allow no upward escape of water under differential head. If salt-water contamination is caused by defective wells, the trouble can generally be located by proper methods of investigation and can be stopped by effective sealing or recasing of the wells. In the Ohio River Basin comparatively little salt-water contamination has thus far been reported. However, it should be recognized that the potential conditions exist and that salt-water encroachment is often a slow and insidious process.

Groundwater quantity

With respect to quantity of water, the basic fact is that groundwater supplies are derived from natural underground reservoirs. The performance of an underground reservoir depends on its capacity and its recharge, and upon a factor not involved in surface reservoirs—the permeability of the water-bearing material. If the material is permeable, the wells will yield copiously without much immediate drawdown, and the popular faith will prevail that there is an inexhaustible supply, quite regardless of the capacity of the reservoir or its rate of recharge. If the rate of pumpage exceeds the rate of recharge, there will be progressive depletion, with ultimate trouble unless there is timely development from an additional source. An insidious feature of groundwater developments is that many of the underground reservoirs have such great capacity that even after years of heavy pumping it may be impossible without systematic investigation to determine whether the pumped water has been replaced by recharge or derived from storage. Pumping from a group of wells necessarily develops a hydraulic gradient from all directions toward the wells, and the resultant cone of depression is inevitably enlarged and deepened as the rate of pumping is increased. Thus, the mere fact of lowering of the groundwater level in the vicinity of pumped wells or of progressive lowering with increased rate of pumping gives no positive evidence as to the existence of overdraft.

In a time of drought, wells may fail because of increased demand and diminished recharge, but generally this is only the proximate cause, while the ultimate cause is likely to be the overdraft which through many years has been leading slowly but surely to failure of the supply.

In March, 1916, the United States Geological Survey responded to an urgent request from the citizens of Canton, Ohio, in regard to the city's water supply, which then as now was obtained entirely from wells. In a field examination of four days, G. A. Waring found that the pumpage for the city waterworks averaged nearly 7 m.g.d., in addition to which there was industrial pumping, and that in the vicinity of the city wells the groundwater level had declined about 5 ft. in 3½ years.

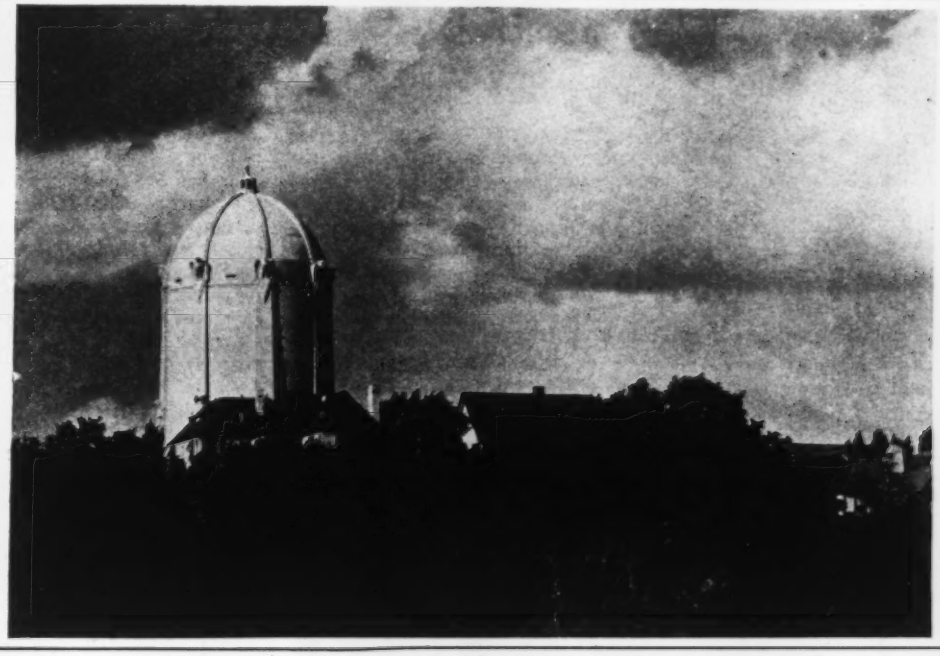
About nineteen years later, in February, 1935, D. C. Warner, executive secretary of the Ohio Water Conservation Board, spoke to an intensely interested group of representative men in Canton on the problem of the city's water supply. In this meeting it was reported that the water supply is still obtained entirely from wells, that the municipal pumpage ranges in general between 10 and 15 m.g.d., the total pumpage between 20 and 30 m.g.d., and that the groundwater level has declined from an original position of 8 to 14 ft. below the surface, to the present position in the vicinity of the city wells of 30 to 100 ft. below. Mr. Warner recommended the construction of two infiltration reservoirs to recharge the underground supply.

Obviously, a very large quantity of water has been pumped through the years from the water-bearing gravel and sandstone at Canton. A systematic hydrologic investigation would disclose approximately how much of this water was taken from storage and how much was supplied by recharge, but a much closer approximation could in the course of time be obtained if such an investigation were followed by periodic measurements or continuous automatic records of the water levels in properly located unused observation wells and definite records of the pumpage from each producing well or well field. With such information at hand, it would be possible to proceed intelligently in making additional developments by wider distribution of the wells or by construction of reservoirs to augment recharge or for direct use. Canton appears to be a fair sample of many cities in the Ohio River Basin and throughout the United States that have adequate water resources but lack basic information and a systematic plan of development.

Extensive survey needed

During the 23 years that the writer has been in charge of the groundwater investigations of the United States Geological Survey he has recommended programs of observation in numerous heavily pumped areas similar to those recommended for Canton. In many of the important areas of groundwater development such programs have been established and carried on, more or less imperfectly and intermittently, for a period of years. There have, however, been almost no funds at any time that were available for the purpose of rounding out such a program and placing it on a substantial continuing basis. In recent drought years, when large sections of the country have been almost entirely dependent on groundwater, there has been great anxiety and much vague conjecture as to the depletion of the groundwater supplies. It is high time to apply common-sense procedure to this major national problem, to the end that reliable periodic inventories can be made of our water resources.

WATER-SYSTEM OPERATION



Improving Water Service by Elevated Tanks and Booster Pumps

A group of five articles reporting the results of the operation of storage and pumping facilities provided on the water-distribution system—They demonstrate the value of these devices in improving pressure conditions and reducing operating costs

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Tanks and Booster Stations Demonstrate Their Value

BY DONALD H. MAXWELL

Alvord, Burdick & Howson, Consulting Engineers, Chicago, Ill.

RECENT DEVELOPMENTS in the introduction of elevated tanks and booster pumping stations in Detroit, Indianapolis, Kansas City (Kan.), and Milwaukee, as described in the following interesting and timely articles, show the increasing realization of the advantages of such facilities for economically correcting undue pressure fluctuations and relieving local water-shortage situations. There are doubtless many other water systems which could advantageously make use of them to improve service and operating conditions or to defer heavy investment in increased feeder mains and main-station pumping facilities.

In the last few years improved facilities have been made available for providing more satisfactory elevated storage. These include the development of elevated tanks of large capacity and relatively shallow depth and improved appearance. For those situations where it is uneconomical to provide sufficient storage to float on the system at all times, reliable control equipment is now available to limit the hours in service. A further development of this idea is the standpipe operated in combination with booster pumps, which may be remote-controlled if desired for peak-rate or for fire-reserve service.

Increasing emphasis is being placed on the sanitary hazards incident to dropping of pressure below the level of the consumer's fixtures. The desirability of more uniform service and the better facilities now available to accomplish it both contribute to the increased interest apparent in elevated storage.

At Burlington, Iowa, the Citizens Water Co. installed a standpipe 65 ft. high, of 1-m.g. capacity, and a booster station with a 2-m.g.d. pump in the southern part of the distribution system in 1925. Experience with the installation was so satisfactory that in 1930 the water company installed a 1.4-m.g. standpipe 60 ft. high and a 2-m.g.d. booster pump near the west limits of the

distribution system to correct local pressure deficiency and to improve further the efficiency of the distribution system. This tank is also to serve as a supply point for a future high-level district.

Installations similar to that at Burlington have recently been made both at Racine and Kenosha, Wis. The Racine installation, made in 1931, consists of a 2¾-m.g. standpipe, 65 ft. high, located near the west city limits. At the present time the standpipe floats on the distribution system, the upper portion absorbing fluctuations in the consumption rate and contributing materially to pumping economy of the new electrically operated main pumping station. The installation has overcome pressure deficiencies in the western portion of the city and has greatly improved the efficiency of the distribution system.

The standpipe at Kenosha, just being completed, is also of 2¾-m.g. capacity and 65 ft. high and similarly located to the one at Racine, floating on the distribution system opposite the pumping station. A 5-m.g.d. booster pump is provided, remote-controlled from the main pumping station. It was estimated that the improvement at Kenosha would make it possible to defer for several years extensive additions to the feeder mains.

At Glencoe, Ill., the pumping station was operated at first without the advantage of elevated storage. The power consumption during 1931 averaged 1,835 kw.-hr. per m.g. delivered to the mains. During the first six months' operation with the elevated tank in service, the power consumption per m.g. averaged 1,235 kw.-hr., or two-thirds of the former power use. The annual saving in power for pumping was estimated at $2,500 per year, or enough to cover interest on investment, depreciation (on sinking-fund basis) and on maintenance of the tank.

The installations described in the following articles should be of great interest to waterworks managers of small plants still operating by direct pressure or to managers of larger plants that have outlying areas in which unsatisfactory pressures prevail during the peak hours of consumption. Elevated storage in many such cases will be found to be an economical solution.

Elevated Tanks in Detroit Eliminate Pressure Pulsations

By George H. Fenkell

General Manager, Department of Water Supply, Detroit, Mich.

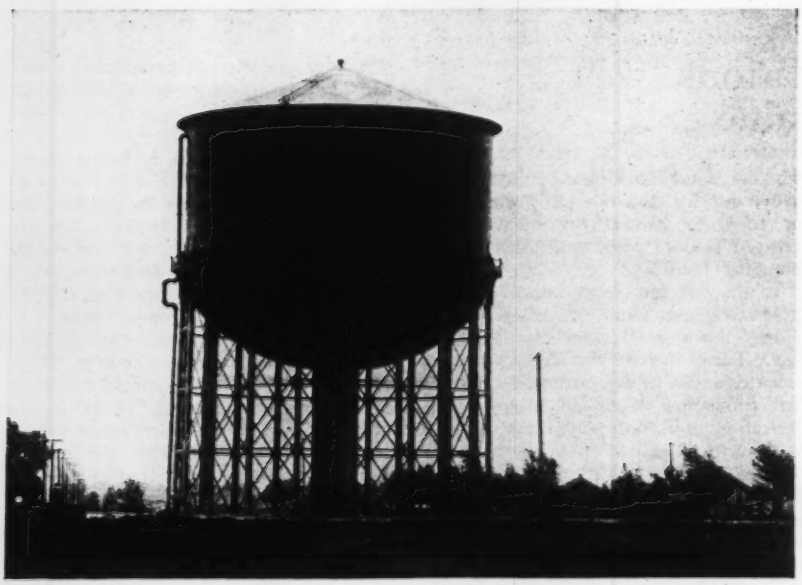
ELEVATED water tanks have been highly effective in Detroit in improving pressure conditions. As compared with other cities, Detroit's water pressures are rather low, and in consequence it is necessary that they be kept fairly uniform. There are now five tanks in the system, four of 1½-m.g. capacities and one of 2 m.g., the first of which was placed in operation in the summer of 1927. The result of their use has been largely to eliminate the pulsation in pressures that would otherwise be inevitable in a closed system. Also, the tanks assist in maintaining fairly uniform pressures during times of maximum demand.

As providing elevated storage for large quantities of water is expensive, to provide sufficient tank capacity to maintain pressures uniform while the tank is allowed to float on the line would in many cases be entirely uneconomical. This has led the writer to the conclusion that the time of filling and the time of discharging such tanks should be closely controlled. To accomplish this in Detroit, the pipe line which leads from the street main to the tank has in each case been designed to allow easy control. A short section of this line is divided into two parts, and a control valve is installed in each part. Thus, there are two valves that may be operated for regulation instead of a single larger valve. These valves can be either manually or automatically operated. An orifice plate has been inserted at each valve to reduce wear on the valve parts during operation and use.

The method of operation involves allowing a tank to ride on the line during the spring and autumn, also in the winter provided the fluctuation in water level in the tank is sufficient to prevent freezing. When the change in water level is inconsiderable, the tank is shut off and drained during the coldest months. During the summer and when there is difficulty in maintaining pressures, the tank is allowed to fill during the night, and the valves are then closed and the water is held until its use is most needed. Thus, during the sprinkling season the first valve is opened about 5 p.m., and the second valve about an hour later. The floor-stands for all of the control valves are provided with motor mountings, but so far the clocks and motors have not been set and the valves are now manually operated.

A study of the possible ways of pro-

FIG. 1—DETROIT ELEVATED TANK holds 2 m.g. The bottom of the tank is 42½ ft. above the ground.



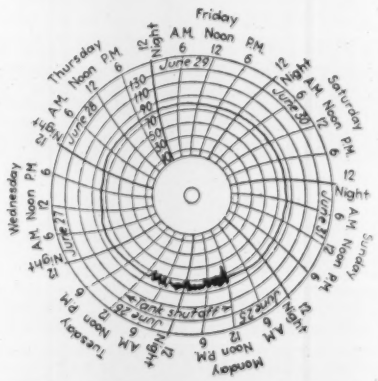


FIG. 2—SEVEN-DAY pressure chart on Plymouth Road elevated storage tank. When tank was shut off for a day, the pressure in the mains at that point fluctuated widely.

viding water storage, to be of service during hours of peak demand, leads to the conclusion that there are several ways in which this problem can be attacked: Water can be drawn into a reservoir at night and pumped into the mains as needed; the bottom of the tank can be set near what will be the normal water level, and the tank can be filled at night by pumping; the tank can be set so that the normal water level will be near the top and the water can be discharged by pumping. Under certain conditions each one of these methods will prove satisfactory, but it should be borne in mind that it is poor economy during times of greatest demand to fill a tank only partly full or to allow the water that has accumulated to be discharged before it is most needed.

Storage on Distribution System Raises Pressures and Reduces Pumping

BY J. P. SCHWADA

City Engineer, Milwaukee, Wis.

IN MILWAUKEE, as in many other cities, the pumping stations are located at considerable distances from the center of consumption. In consequence, water leaving the pumping stations travels long distances in the distribution system before reaching the consumers. With the growth of the city during recent years, these distances gradually became longer until finally in the outlying high areas entirely inadequate pressures were obtained. In some places the pressures during the sprinkling periods on extremely warm days were so low that no water could be obtained.

In order to improve the situation, a rather comprehensive investigation was made as a first step. Recording pressure gages were installed throughout the city, to obtain a continuous record of pressure conditions. Data on the flows in the feeder mains were obtained by means of recording and manually read pitometers. Peak daily and hourly rates of pumping for the past ten years were plotted, and the curves were projected to determine the probable future requirements. Studies were made of population and area growth, and the rate and variation of water consumption in various types of areas were determined. Among other things it was found that in some residential areas the peak sprinkling demand for water was eight times the yearly average. On further study of this peak demand it was found that the volume of water required was comparatively small. The water was demanded at a very high rate but for a very short period of time.

To illustrate the situation, two highly built-up areas will here be considered, one 5 miles from the pumping stations and the other 12 miles. Both areas were experiencing low water pressure several evenings a year during the sprinkling period. In the area 12 miles from the pumping stations the pressure would drop to zero and remain there for an hour or more. In the other area the pressure would drop to 3 or 4 lb. per sq.in.

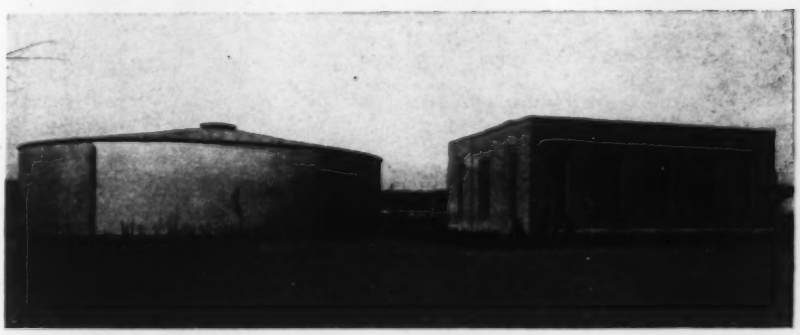
To improve these conditions in the most economical manner, two 1.5-m.g. elevated storage tanks were erected and placed as near as practicable to the areas that had been experiencing the low pressures. The effect of these tanks was carefully studied, and the favorable results obtained led the city to consider storage on a larger scale to take care of the future pumping requirements beyond that due to sprinkling only.

Milwaukee is not favored with a natural elevated site in the high-service area which would be suitable for elevated storage on a large scale. Consequently, it was decided to select a suitably situated site, erect storage tanks at ground level and to insall a small station with booster pumps to get the water out of the tanks and into the distribution system. The site chosen for the booster station is at the intersection of two large feeder mains, affording ample inlet and outlet pipe capacity. The plan adopted contemplates two 6-m.g. steel tanks, each 165 ft. in diameter and 37 ft. high. One of these tanks has been erected and was used last year, together with the booster station which houses one 20-m.g.d. motor-driven centrifugal pump.

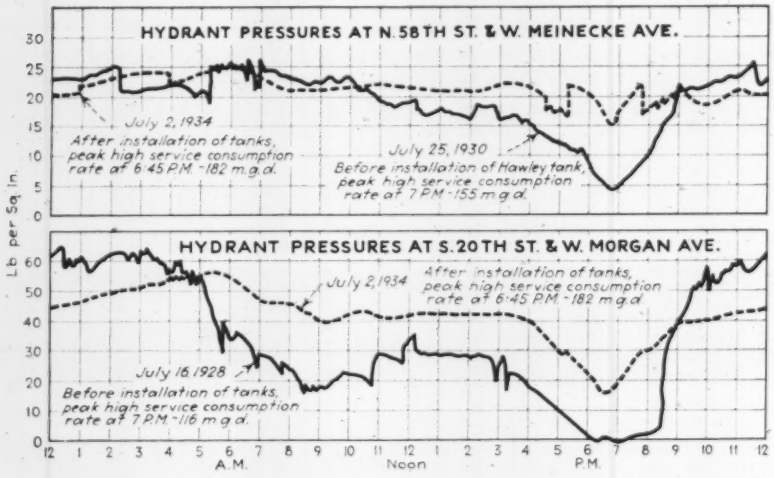
As some future date the other 6-m.g. tank will be erected, and the pumping capacity of the station will then be increased from 30 to 120 m.g.d. according to requirements.

The tanks are used in the summer

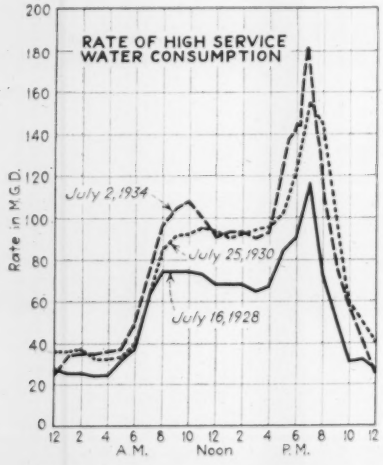
ELEVATED STORAGE TANK of 1.5-m.g. capacity at Hawley Road.



BOOSTER PUMP STATION and 6-m.g. storage tank.


HYDRANT PRESSURES AT N. 58TH ST. & W. MEINECKE AVE.
Lb. per Sq. In.
July 2, 1934
After installation of tanks, peak high service consumption rate at 6:45 P.M. - 182 m.g.d.
July 25, 1930
Before installation of Hawley tank, peak high service consumption rate at 7 P.M. - 155 m.g.d.
HYDRANT PRESSURES AT S. 20TH ST. & W. MORGAN AVE.
July 2, 1934
After installation of tanks, peak high service consumption rate at 6:45 P.M. - 182 m.g.d.
July 16, 1928
Before installation of tanks, peak high service consumption rate at 7 P.M. - 116 m.g.d.
A.M.
Noon
P.M.

EFFECT of tank operation on hydrant pressures at two different points in the distribution system.



RATE of high-service water consumption has increased since tank and booster installations from a peak rate of 116 to 182 m.g.d., and still a satisfactory service is maintained.

time only, are drained in September and are kept out of service until May. They are filled at night when the consumption demand is low and are shut off automatically when full. One of the 1.5-m.g. elevated tanks floats on the line. The other elevated tank and the booster station, on the other hand, are only operated when the demand for water is excessive.

The use of the tanks has made it possible to furnish water at satisfactory pressures in the two high areas referred to even during the evening sprinkling periods. In the one area, where formerly the pressure charts indicated zero for as long as two hours, the minimum pressure last summer during the peak consumption demand was 16 lb. per sq.in. In the other area, where formerly the pressure would drop to 4 lb., the minimum pressure last summer during the peak consumption demand was 15 lb. This improvement in pressures was obtained in spite of the fact that the peak hourly consumption rate in the high-service area increased from a 116-m.g.d. rate to a 182-m.g.d. rate, an increase of 57 per cent, during the past six years.

It is of importance to note that the use of the tanks has cut down the large variation in the pumping rates at the major stations, especially on peak days. Then, too, the feeding of water to the distribution system from several locations has reduced the velocities in the feeder mains, which in turn has decreased the pressure losses. Of still greater importance is the fact that the use of storage has postponed for several years the construction of another major pumping station, tunnel and feeder mains which had been previously contemplated and tentatively planned. With a pumping capacity of 120 m.g.d., the booster station serves as a major station during the short periods of high consumption.

The storage tanks in conjunction with the booster pumps are therefore serving satisfactorily in the Milwaukee waterworks system and have proved themselves to be a valuable adjunct to its operating facilities.

Indianapolis Pressures Improved And Pumping Costs Reduced

BY W. C. MABEE

Chief Engineer, Indianapolis Water Co., Indianapolis, Ind.

SINCE the 1.5-m.g. elevated storage tank was installed at the extreme eastern edge of Indianapolis by the Indianapolis Water Co., observations made in the Irvington high-pressure district, serving a population of 64,000 people, indicate that ample service with adequate volume has been maintained even during periods of excessively heavy draft. Pressure measurements made immediately after the tank was placed in operation in 1931 during the peak loads of a high consumption period are compared in the accompanying charts with measurements made under similar draft conditions before the tank was put in service. Part of the Irvington district, the area known as Beech

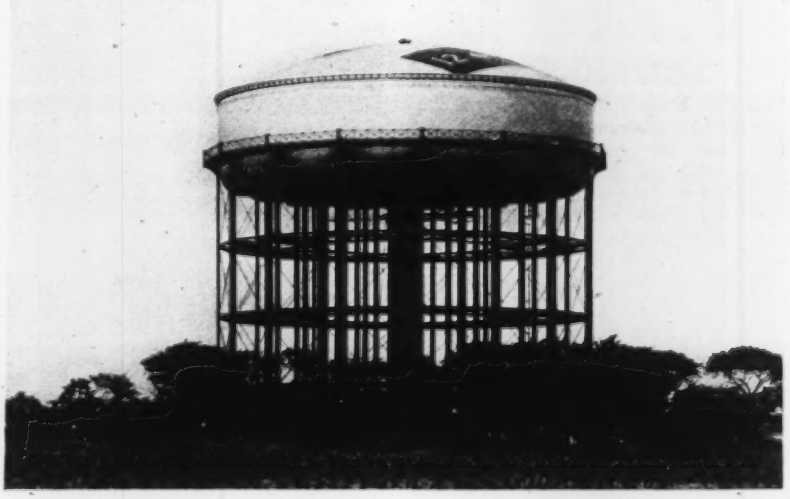


FIG. 1—ELEVATED TANK having a capacity of 1.5 m.g., installed by the Indianapolis Water Co. at the eastern edge of the service area.

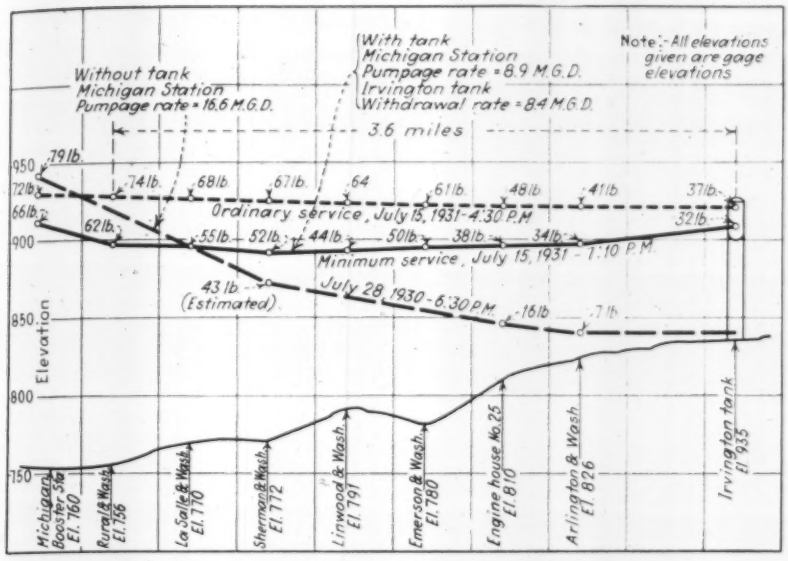


FIG. 2—HYDRAULIC GRADIENTS before and after the installation of the Irvington elevated tank.

Grove, did not show the degree of improvement noticeable elsewhere, however. The difference is attributed to the fact that this town is supplied from a single force main and the entire supply of water is taken at the extremity of the pipe line, with no gridiron available to support the feed.

The Irvington tank (*ENR*, Feb. 25, 1932, p. 281) is of the radial-cone-bottom type, 97½ ft. to the top with a 25-ft. water depth. The water in the tank floats on the system at all times. The tank is equipped with altitude-valve control, automatic heating equipment and tank-level transmitter to a pumping station 11 miles away.

Before the tank was installed, the heavy draft in the Irvington district, occasioned by the extreme hot dry weather, had established a heavy pumpage record of 19 m.g.d. at the Michigan booster station, leaving no reserve machinery available for a possible breakdown or other interruption in service. After the tank was in service, the booster station pumped at a maximum rate of 9 m.g.d. between the hours of 7 and 8 p.m. with 10-m.g.d. pumping capacity in reserve. The tank during that hour was discharging at a rate in excess of 10 m.g.d. and maintaining a relatively flat hydraulic grade over the entire district.

This desirable result was made possible by the efficient use of the gridiron system in reducing high velocities and consequent high friction head losses. Losses were kept at a minimum by reason of reduced velocities and shorter distances between sources of pressure and areas of consumption; the district is now fed from one end by the booster station and from the other end by the elevated tank, a dual feed into the pipe system at its extremities.

The tank also provides better service by maintaining higher and more adequate pressures in regions of greatest demand, making available more water for withdrawal from the system, which, without the tank, would not otherwise have been available. This is illustrated by the hydraulic grade line shown on Fig. 2, marked July 28, 1930, as compared with the hydraulic grade line, marked July 15, 1931, before the tank went into service.

Another favorable result of the tank installation has been the elimination of violent changes in pressure due to unusual draft by large consumers. The pressure chart from one of the city fire-engine houses shows that the tank acts as a stabilizer by automatically supplying the demand for volume and avoiding the time lag required by pumps. This results in a damping of the objectionable fluctuation in pressure on the system.

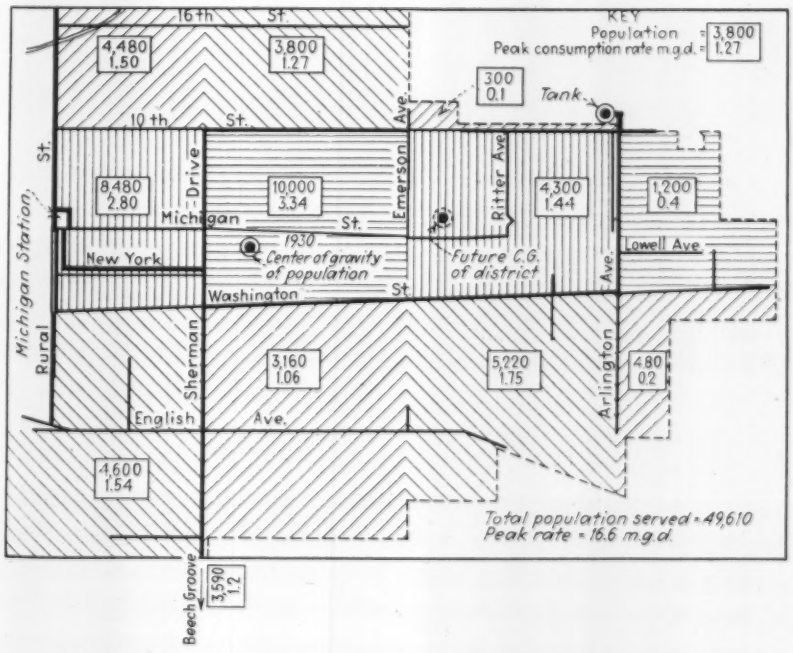
Another advantage of the tank is the releasing of pumping equipment for reserve, to meet an occasional breakdown in the service.

By supplying a substantial contribution of water to the arterial system during the peak demand hours, the tank has reduced the maximum hourly rate of both primary and secondary pumpage. At the time of the test the tank actually furnished one-third of the demand of the district supplying 64,000 persons.

It was found that by reason of the reduction in velocity in the mains and consequently the reduction in friction losses it was possible to hold a lower pressure at the stations, the result of which would naturally indicate a saving in power cost.

The reduction of the maximum pumping demand at the booster station resulted in a noticeable benefit to the suction side of the station by permitting a higher suction pressure due to lessened velocity in suction pipes. The region on the discharge side of the booster station was benefited by more uniform pressure.

In the district served exclusively by the Michigan booster station, supplying



RIG. 3—IRVINGTON high-pressure district receives its supply from the Michigan booster station. The elevated tank is near the district's eastern edge.

50,000 persons, the tank met 50 per cent of the peak demand with a substantial reserve for fire demands.

Between the hours of 4:30 and 8 p.m., a 14.4-ft. depth of water was withdrawn from the tank, equivalent to 864,000 gal.; the maximum rate of withdrawal was 11.6 m.g.d., the minimum rate 1.7 m.g.d., and the average rate for the four hours 5.9 m.g.d.

Kansas City, Kan., Installs Five Tank and Booster Districts

By JAMES D. DONOVAN

Manager of Production and Distribution, Board of Public Utilities, Kansas City, Kan.

OWING to the rough contour of Kansas City, Kan., to derive the utmost in economy in waterworks operation, it was deemed advisable when the plant was put under the present management in 1929 to establish booster pump stations to maintain adequate water pressure in the higher sections of the city, and thus avoid the necessity of carrying excessive pressures on the main distribution system.

The higher sections, for the most part, are residential districts, while the larger commercial and heavy industrial consumers are located in the lower sections.

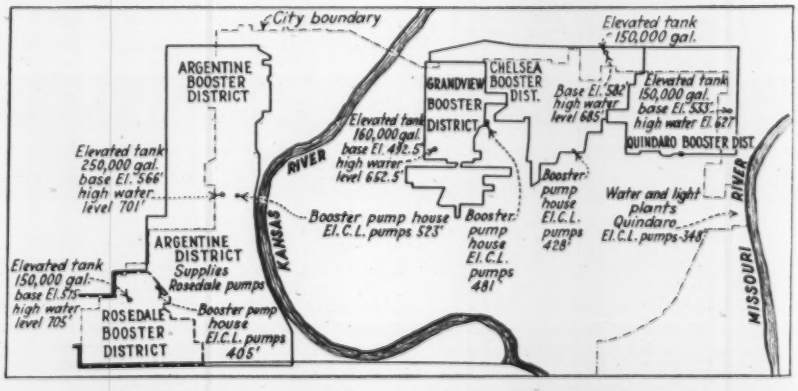
There are five booster districts, known as the Quindaro, Chelsea, Grandview, Argentine and Rosedale districts. Each is served by a booster pumping station and an elevated steel water-storage tank. Total elevated storage amounts to 850,000 gal. Three of the tanks and one booster pump station were constructed in 1934, and it was at that time that the Rosedale booster district was created. Two of the four booster districts previously created were supplied by continuously operated booster-pumping equipment prior to the erection of the elevated tanks. Other water storage in the system consists of a 13-m.g. concrete and earth reservoir, which floats on the main distribution system and provides an emergency supply and absorbs peak demands on the system.

The city's water supply is obtained from the Missouri River, which runs along the north side of the city. The water and light plants, known as Quindaro Station, are located on the river's south bank.

The Quindaro Station supplies directly the major industrial consumers, a large part of the domestic and commercial consumers and all booster-pump stations, except the one in the Rosedale district, which obtains its supply from the Argentine district elevated tank and booster pumps. The tank-and-booster system permits a reduced pumping pressure at Quindaro, assures adequate pressure for consumers in the booster districts and provides adequate supplies of storage water to guard against interruption of service in each district in the event of temporary failure of electric power supply to any of the pumping stations. The estimated savings in pumping costs for the whole water system, as now constituted, compared with the cost of direct and continuous pumping from Quindaro Station amounts to about $10,000 annually. Establishing the booster districts has also resulted in an increase in pressure of from 5 to 10 lb. per sq.in. in each of the several districts and has permitted a decrease of about 10 lb. in the pumping pressure at Quindaro Station.

The operation of the booster-pumping equipment in conjunction with the tank is essentially the same in all the five booster districts. Each booster-pump station contains two motor-driven centrifugal pumps arranged for preferred-emergency service. The preferred pump operates intermittently, as required, to supply water to the booster district and to fill the elevated storage tank. Its operation is entirely automatic, being controlled by water pressure in the district. The pump runs until the tank is filled, when an altitude valve in the supply line to the tank automatically closes to prevent overflow. On closing the altitude valve, pressure in the mains of the district rises, and the pump in operation is stopped by a pressure governor equipped with electrical contacts. The pump remains idle until about 30 per cent of the water in the tank has

ELEVATED TANK of 150,000-gal. capacity for the Rosedale district. The tank is operated in conjunction with a booster pumping station.


City boundary
ARGENTINE BOOSTER DISTRICT
Elevated tank 250,000 gal. base El. 566' high water level 701'
ARGENTINE DISTRICT Supplies Rosedale pumps
Elevated tank 150,000 gal. base El. 575' high water level 705'
ROSEDALE BOOSTER DISTRICT
Booster pump house El. C.L. pumps 405'
KANSAS RIVER
Elevated tank 160,000 gal. base El. 492.5' high water level 652.5'
Booster pump house El. C.L. pumps 523'
GRANDVIEW BOOSTER DISTRICT
CHELSEA BOOSTER DIST.
Booster pump house El. C.L. pumps 481'
Booster pump house El. C.L. pumps 428'
Base El. 582' high water level 685'
Elevated tank 150,000 gal.
Elevated tank 150,000 gal. base El. 533' high water El. 627'
QUINDARO BOOSTER DIST.
Water and light plants Quindaro El. C.L. pumps 348'
MISSOURI RIVER

KANSAS CITY, KAN., has five high-pressure districts, each of which is served by an elevated storage tank and automatic booster pumps.

been used. The resulting decrease in pressure in the district mains starts the pump refilling the tank again. The emergency pump is held in reserve. It is set to start at a lower pressure than the preferred pump and operates only in event of exceedingly heavy usage in the district such as might be occasioned by a fire. The booster-pump stations are unattended, only daily inspection being required.

The Quindaro booster district has a 150,000-gal. elevated tank and two 500-g.p.m., 80-ft.-head pumps. The Chelsea booster district has a 150,000-gal. elevated tank and two 400-g.p.m., 150-ft.-head pumps. The Grandview booster district has a 150,000-gal. elevated tank and two 500-g.p.m., 125-ft.-head pumps. The tank in the Argentine booster district has a capacity of 250,000 gal., and each of the two booster pumps is rated at 3,500 g.p.m. at a head of 220 ft. The Rosedale elevated tank has a capacity of 150,000 gal. and each booster pump is rated at 1,000 g.p.m. at a head of 65 ft.

The water system serves a total of 28,375 customers, of which 25,935 are domestic, 2,132 commercial and 308 industrial. The average daily pumpage for the year 1934 was 15,900,000 gal., with a maximum day of 24,000,000 gal. and a minimum day of 11,150,000 gal.

New Equipment and Materials Aid Water Engineer's Task

By incorporating new and improved materials into their products and by attention to better design, the manufacturers of waterworks equipment and materials have increased their value, durability and field of usefulness

BY THOMAS H. WIGGIN
Consulting Engineer, New York, N. Y.

THE water-service problem is one of a continually developing nature. Those charged with the responsibility for water service must prosecute vigorously the development of the science and industry on which they depend for successful accomplishment. Scientists, engineers, system operators and manufacturers of materials and equipment have all felt this duty in the past, and the degree of success that has been achieved in providing proper water service to American communities can be attributed to their joint efforts. It is the purpose of this article to give brief discussions to the contributions already made by the last-named member of this group, the manufacturer of equipment and materials, to indicate the lines along which his development and research are now proceeding, and to point out those specific fields in which further developments are greatly to be desired.

Perhaps the most marked progress in waterworks during recent years has been in the art of constructing and protecting transmission and distribution mains.

In the past few years two processes have been developed for casting pipes centrifugally, and pipe so made is rapidly replacing the pit-cast type of pipe which has for the past century been used so extensively. In one of these new processes the metal is cast against a revolving water-cooled metal mold, and in the other process the mold is lined with sand; no core is required. The pipe cast against a metal mould requires annealing, but the process has recently been improved to reduce the chilling effect of the mold. Production of these centrifugally cast pipes began with the small sizes but has been rapidly extended until 30-in. pipes are not uncommon, and larger sizes will doubtless be generally available in the not-distant future. The centrifugally cast iron is stronger than the pit cast, and the pipe is made correspondingly thinner.

In recent years also, methods of casting pipe horizontally with green-sand molds have been improved, notably by the use of multiple gates into which the metal is poured simultaneously from a number of small ladles supported on the same shaft.

The manufacture of electric-fusion or arc-welded steel pipes has reached a high state of efficiency by the aid of automatic welding machines. Several reputable companies are competing in this market, and such pipe has almost entirely superseded riveted pipe and lockbar pipe, being generally more efficient as to joints and having smooth interior and exterior surfaces which favor a high coefficient of carrying capacity and permit the convenient application of protective coating.

An improved and greatly strengthened spiral steel or iron pipe with interlocked and welded joints has also been developed, which may be had with cement mortar lining and, if desired, with cement mortar covering.

Parallel with, or rather antedating, these developments in metal pipes has come noteworthy development in reinforced-concrete pipe made both by the spinning and mold-casting processes. A cylinder of steel with metal jointing rings welded on at the ends is embedded in one type of reinforced-concrete pipe used for heads exceeding about 75 ft.

An asbestos and cement pipe, made by wrapping around a mandrel (under pressure from rollers) successive layers of the mixed material, screened as in paper manufacture from hydraulic suspension, is now being marketed in this country. This is an Italian development.

Protective coatings

Even more important than the new materials for the metal pipes themselves are the protective coatings that have been developed. A notable effort to attain permanence in capacity of distribution systems was made in New England during the last half of the past century in the fabrication and extensive use of cement-lined riveted steel pipes in diameters from 4 in. to about 16 in. One case of a similar pipe about 40 in. in diameter is known in New Jersey. These pipes were successful, and some are still in use, but they were too thin for modern pressures, and the exterior was not always well protected.

About 1910 the writer designed and there were built in inverted siphons of New York City's Catskill Aqueduct many miles of riveted steel main of 9-to 11½-ft. diameter, which was jacketed with concrete and lined with 2 in. of poured mortar. These have nearly maintained their original high flow coefficient of 145 to 160. During the same period there was introduced the bitumastic enamel coating, of heavy refined coal tar and mineral filler, for the Narrows cast-iron submarine pipe of the New York Catskill system. Soon after, the writer was instrumental in extending the use of this material to the 66-in. and 72-in. steel pipes laid in Brooklyn. These coatings, after fifteen years of use, are still in excellent condition and have formed the basis of further developments in the use of this material.

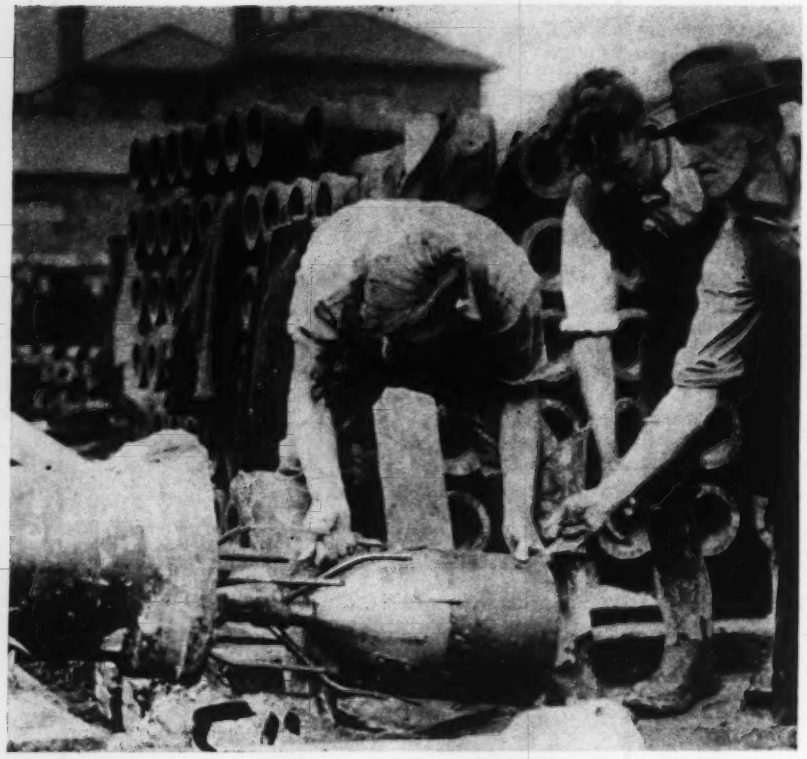


FIG. 1—CEMENT LINING OF CAST-IRON PIPES while in the ground makes use of a special mandrel, which is drawn through the pipe, distributing the cement mortar, which is introduced ahead of it. This view shows a demonstration of the process being conducted in a pipe yard.

J. E. Gibson, of Charleston, S. C., was responsible for the beginning of an important movement about 1922 for lining cast-iron pipe with cement mortar. At first the mandrel method was used as in the old riveted pipe of the last century, but soon the spinning method being used in England was introduced here, and a little later there was introduced spun bitumastic enamel lining for cast-iron pipe.

These developments have continued. The spun linings are now being applied to steel pipe; exterior coatings of tar enamel or cement mortar or both (with the enamel next to the pipe) are being applied by highly developed wrapping methods; reinforcing mesh is sometimes used in the exterior covering. The efforts of the petroleum industry to protect its thousands of miles of steel pipes in corrosive ground in the West are responsible in large measure for progress in this exterior protection.

The engineer of today, it will be seen, has available richness and variety of excellent pipe materials, having either in themselves, like the concrete and the asbestos pipes, a high degree of permanence in carrying capacity, or having efficient protective coatings, giving promise of great permanence in carrying capacity. Enterprising and well-informed engineers have for a decade or more taken advantage of these materals as they became available. They appreciate the fact that it is capacity one pays for in a water line, not metal or concrete to bury in the ground.

It would be easy to infer that the problem is now solved and that it is only necessary to make use of the goods provided, but statistics show that the general run of water supplies are still using tar-dipped cast-iron mains instead of availing themselves of cement or bituminous linings for these pipes. Most superintendents are apparently unaware of the fact that a small quantity of rust and tuberculation will cause a great reduction in carrying capacity. They will say that their pipes do not tuberculate, although tests would often show that they have coefficients of only 50 to 80 or less as compared with 140 when the pipes were new. Only by gradual education will an appreciation of the value of carrying capacity be inculated.

Improving old mains

Desmond FitzGerald tried 40 years ago to recondition the cast-iron siphon pipes of the Boston Sudbury Aqueduct. He cleaned out the tubercles and applied a new tar coating of the best kind he could find, but the new coating quickly deteriorated.

Cleaning of mains in place by the use of a traveling scraper or "go-devil" has been practiced for a good many years, and there has been a gradual improvement in the apparatus to remove the rust and tubercles effectively without badly injuring the remaining coating. The limitations of this method lie in the subsequent growth of tuberculation, which requires repeated cleaning at intervals. There may be an important field of study in correlating the growth of tuberculation subsequent to cleaning with the improved methods now in vogue in some water supplies of treating the water, so as to render it less corrosive.

During the past three or four years attention has been drawn toward the reconditioning of existing mains by cleaning and recoating them in place. In this country several large steel mains have been cleaned of bituminous coating and recoated with bitumastic enamel. The smallest main so far treated was 36 in. in diameter. A machine for applying a smooth lining of cement mortar to mains in the ground, when the diameter is 36 in. or more, has been invented by A. G. Perkins and is being tried on short stretches of main. In New Zealand, in Australia and in England a process of applying a cement mortar coating of any desired thickness between 1/8 in. and about 3/8 in. to cast-iron or steel mains of 3- to 16-in. diameter in the ground is being used successfully. The writer recently inspected this work in Manchester, England. The flow coefficients obtained in 3-in., 4-in. and 5-in. pipes, as measured under the writer's supervision, were respectively 65, 80 and 97, reckoned on nominal diameter, and were over 140 reckoned on actual diameter within the mortar lining. Linings were 5/16 to 3/8 in. thick. In larger pipes with thinner linings the coefficients reckoned on nominal diameters would be from 110 up.

Improved pipe joints

For bell-and-spigot pipe sulphur compound joints continue to make gains over calked lead on account of the cheapness and superior tightness. Only a few failures have been recorded during the 25 years of their use.

The necessity of tight joints for gas mains has stimulated the invention of a number of types of bolted joints having rubber gaskets or packers with or without separate glands, and the designs have been adapted to water pipes. A bolted-sleeve coupling that has been widely used for gas and oil lines is also used to some extent for water-supply mains, particularly as an occasional expansion joint in lines where welded joints are used for the majority of the joints. Leak clamps to fit over defective bell and spigot joints are in successful use both for gas and water.

The manufacture of rubber for gaskets and packing has been greatly improved, and even without change it was of proved permanence where protected from surface exposure. Rubber joints appear to be successful, and there

is a tendency toward their more frequent use in water supply, in suction lines where vacuums must be maintained, in submarine lines or lines on bridges where flexibility and tightness are required, and in small mains where the bolted joint is a convenience.

Valves and check valves

Gate valves have not changed much in recent years. The use of nickel steel and high-strength bronze stems was developed in an earlier decade, and the bronze is now the common material. The American Water Works Association is at present engaged in a thorough study with a view to standardizing valves by the establishment of minimum thicknesses and dimension of parts founded on the best practice.

Great progress has been made in the design of check valves, and valves have been developed giving less loss of head and less slam when closed by the shutting down of an automatically operated pump, or in case of failure of electric power. There has been a great demand for these improvements since designers have recognized that the heavy loss of head, often running into several feet, occasioned by the old-fashioned swing check, was a constant expense in energy which justified a reasonable investment to eliminate. Furthermore, the water hammer is a menace.

The improved checks are of two general types, and in addition, an adaptation of the needle valve is available. One type is the plug type which, when open, gives a clear port matching the pipe and which is closed automatically, this closing being facilitated by a lifting mechanism that raises the plug a little from its seat during turning. This type of valve and the needle valve are also used as altitude valves for the automatic control of water elevations in tanks.

The other type is an improved swing check. In some makes the improvement is only in respect to refinements in waterway, so as to reduce the friction loss, but in another style the flap is hinged off center so as to lessen the slam occasioned by closing.

Companies specializing in the prevention of water hammer in force mains employ the automatic check valve with controlled speed at closing as an important adjunct.

Service pipes

For centuries the market has provided practically non-corrodible service pipes in the form of lead. However, with the advent of wrought iron and steel, lead began to be replaced with these materials in many places on account of their low first cost, and in a few cases because of the danger of solution of the lead.

Early in the present century lead-lined steel pipe made in Wakefield, Mass., and cement-lined pipe made in Lynn, Mass., were added to the available material for services, and have had considerable use in the East. During the past decade further impetus has been given to the use of cement-lined steel pipe. Cement-lined cast-iron pipe in diameters from 1¼ in. up has also been made available and is becoming increasingly used for the larger water services.

In addition to the lead and ferrous pipes, red brass pipes and copper pipes have come strongly into the field in recent years. There is now a richness of available material for services just as there is in materials for main pipes, and it is hard to predict how the situation can be much improved. Pipes constructed of exceedingly strong tough glass have been mentioned as a possibility, under an invention which has not yet been sufficiently developed to permit prediction of its future.

Venturi meters and flumes

The venturi meter, invention of the late Clemens Herschel, has continued to increase in use as the most generally satisfactory meter for measurement of flow from pumping stations or in mains. Progress has also been made in the design of recording and registering devices. There has recently been installed in Providence, R. I., a 10-ft. Parshall measuring flume, which utilizes the principle of the venturi and attains similar accuracy. This device is useful in measuring the flow of water or sewage in open conduits.

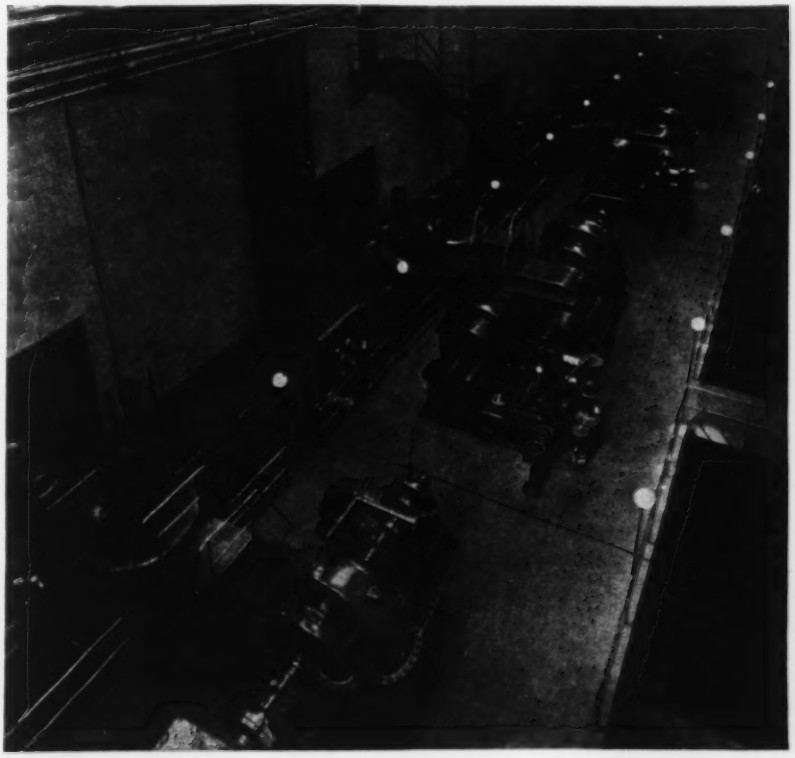
Tanks

Years ago the standpipe gave place to the elevated tank in the flatter regions of the country. It substitutes valuable water storage at a high level for relatively useless storage near the ground. This development is now being carried a step further through the use of shallower, flat or girder-and-plate-bottomed tanks for the hemispherical-bottomed tanks of recent decades.

Telemetering

Invention has been active in the production of highly elaborated apparatus for remote recording and regulating. Pressures or levels in mains or tanks may be recorded at a remote point through electric connections, and pumps or valves can be operated automatically at either point to maintain the desired elevations or pressures. This type of apparatus has been highly developed in fire-alarm work, and the fire apparatus is adaptable for water supply. A plan has been worked out for sectionalizing by valves the New York City water-distribution system so that a section of the city may be cut off by closing gates around it either manually or

FIG. 2—MAIN PUMP ROOM of the Western Ave. pumping station, Chicago, Ill. Four 75-m.g.d. centrifugal pumps are driven by steam turbines through suitable trains of reduction gearing.



automatically in case of break. The more elaborate control systems generally use special three-wire circuits, but the indicating and recording systems may be operated through leased telephone wires.

Purification-plant equipment

Dry-feed machines for feeding alum, lime, iron compounds, charcoal and other similar chemicals used in water-purification and softening plants are becoming the general rule, although solution-feed methods were more commonly employed in earlier decades. These machines have been greatly improved in efficiency and in freedom from clogging. In the large sizes particularly, they are frequently hung on scale beams, to permit accurate record of weight of chemical used.

Machines for the application of chlorine and ammonia are constantly being developed and improved. The vacuum-type chlorine-feed machine with use of water ejector is the prevailing type and has superseded the dry-feed type and the pulsating solution feed machine to a large extent, though the pulsating machine is still regularly used for smaller supplies.

Automatic control of chlorine feed proportional to the flow of water is now on a reliable basis, though the expense involved has precluded its widespread use.

The ton containers for chlorine have become increasingly used on account of the reduced unit cost of the chemical and infrequent renewal they make possible. Fear of a catastrophe from the escape of large quantities of chlorine from these containers has been found to be unwarranted as operators have been able to stop leaks temporarily by the freezing of water thrown over them. Arrangements of the containers so as to facilitate this water treatment are advisable.

Alum continues to be the most commonly used coagulant, but ferric sulphate and chlorinated copperas are also being used to some extent. A plant at Providence, R. I., is using ferrous chloride prepared at the plant by action of chlorine on iron scrap.

Ammonia is used increasingly with certain waters to permit carrying larger residuals of chlorine and to prevent formation of taste-producing compounds by the applied chlorine.

Activated carbon is by far the most spectacular of the new materials used in water purification. The original experiments made by John R. Baylis at the Chicago experimental plant and by others following the Chicago precedent looked toward the use of granular activated carbon in a bed similar to those of sand filters, to be used following filtration through sand. The developments during the past five or six years however, have been largely in the use of activated carbon in powdered form

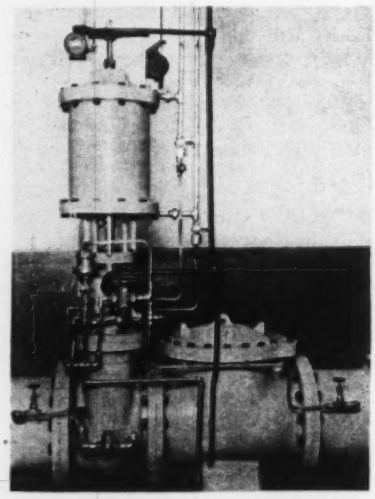


FIG. 3—ELECTRICALLY CONTROLLED, hydraulically operated shutoff valve at the Guilford Station of the Baltimore, Md., water department.

applied as a consumable material, and filtered out on top of the sand filters. Activated carbon appears to be effective in removing almost all kinds of objectionable tastes or odors likely to be present in a water supply and is also effective in removing excess chlorine.

For the conveyance of corrosive chemical solutions, particularly of alum, there are now available hard-rubber and hard-rubber-lined pipes, valves, cocks and fittings; lead pipe, aluminum bronze, high-silicon cast iron, high-nickel-chromium-silicon alloy steel, and other ferrous alloys containing several or all of the following: nickel, copper, chromium, manganese, and silicon.

Pumping equipment

The high-duty, double- and triple-expansion steam pumping engines, have given place to the centrifugal pump, which is generally driven by an electric motor. Efficiencies of centrifugal pumps have mounted until now an efficiency of 78 to 82 per cent of pump alone is easily obtainable in the smaller units. The efficiencies go up with increased capacity. Recently at Chicago an efficiency of 91.5 per cent was obtained from units of 50-m.g.d. capacity when operating against a head of 136 ft. at a speed of 514 r.p.m. It seems probable that efficiencies comparable with those obtained with hydraulic turbines, which now reach 94 per cent for large units, will be equalled by centrifugal pumps.

Electric motors have also been improved in efficiency, 98.41 per cent having been obtained in synchronous motors of 1,500 hp. used in the Chicago installation referred to above. Steam-turbine-driven centrifugal pump units in large capacity can be had to equal in duty the vertical, triple-expansion high-duty steam pumps of the past era.

Electric centrifugal pumping units have the fault of inflexibility in capacity which operators find inconvenient, especially when they consider the perfect flexibility of steam-driven units. Pumps with flat head-capacity curves combined with slip-ring motors having a limited speed regulation compensate in part for this lack of flexibility, but a field remains for the development of an electric drive with adequate speed regulation obtained without material loss of applied energy.

The diesel engine is also increasingly available, and where electric power rates are high it serves as a check on such rates, since electric companies will generally find rates that permit retention of the business.

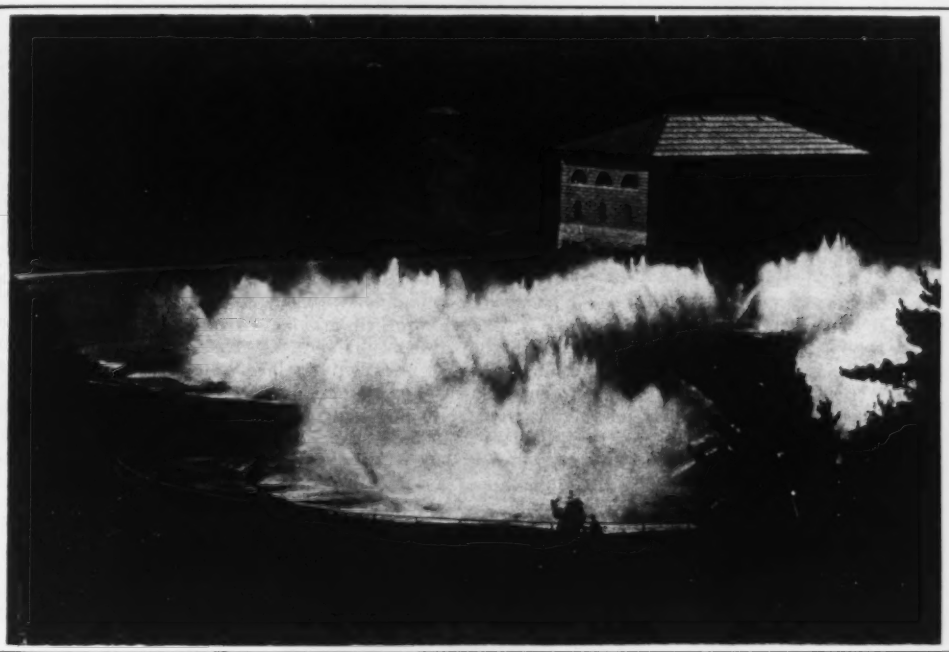
Vertical and multi-stage turbine centrifugal pumps with extension shafts and discharge pipes for setting in deep wells have been continually improved in ruggedness and efficiency and may be had in several good makes with efficiencies up to 85 per cent in the larger sizes. The vertical electric motor has been correspondingly developed to give efficiencies equal within a fraction of 1 per cent to those of horizontal motors of similar horsepower. These deep-well pumping units may be had in any desired number of stages so as to provide pressure for pumping into a reservoir or directly into the distribution system. The latter arrangement, with automatic control by pressure, is the rule.

Cement and concrete

Special cement, which generates less heat in setting, has been used in several large concrete dams. In addition to the use of this special material, an elaborate system of cooling pipes embedded in the masonry was used in the construction of Boulder Dam, to assist in preventing excessive heat and the resultant serious cooling strains. Quick-setting cement, made so by extra-fine grinding, and high-alumina cement of extra strength and speed of setting are also available. Some progress is reported on cement that is resistant to solution by soft water, but this is not yet in common use.

Methods of conveying and compacting concrete in dams, tunnels and other works continue to be developed. More than ten years ago pneumatic conveyance of concrete was brought to a high state of practicability in the construction of tunnels. Recently a concrete displacement pump has been developed and was used in a dam forming a part of the water supply serving Hartford, Conn. A type of vibrator for use within the body of the concrete has been added to the type previously used which was attached to forms. The new type is apparently proving more satisfactory. Vibrators add considerably to the density of concrete and its freedom from honeycombing. Embedment of steel is improved by their use.

WATER-PURIFICATION PROGRESS



Flexibility in Design Aids Purification-Plant Operation

Rising standards of water quality and the consequent growing complexity of water-purification practice require that the filter-plant designer provide a high degree of flexibility

BY PAUL HANSEN

Consulting Engineer, Chicago, Ill.

IN VIEW of steadily increasing standards of water quality and increasing elaboration of processes for purification of water made available by experience and research, it becomes encumbent upon engineers who design water-purification works to provide ample operating flexibility in the design, to give operators adequate latitude in meeting changing conditions in raw water and also to permit enlargements and elaborations of works without destroying good arrangement of component elements. Flexibility also facilitates meeting emergency conditions that are apt to arise at almost any water-purification plant.

Before proceeding with the discussion of flexibility in design, it may be well to consider the relation between the designer and the operator of water-purification plants. The designer is invariably an engineer. He must thoroughly understand hydraulics and sanitary science and must be familiar with various forms of structural design. Many engineers, however, who design water-purification works have at some time operated such works. Such experience greatly improves their judgment in connection with design, and they are more likely to provide for flexibility in operation than engineers who have not had this experience.

All engineers attempting to design water-purification plants should acquaint themselves with operation problems as fully as possible by frequent visits to filter plants and by keeping abreast of the literature, now extensive, on water-purification plant operation from the operator's point of view. Where additions are to be made to existing purification works, the filter-plant operator should be freely consulted because he can often contribute practical suggestions of great importance.

The filter-plant operator may be an engineer as well as chemist and biologist, but usually he has had comparatively little experience in design and construction. Nevertheless, within recent years the operators have contributed greatly through their research, experience and writings to the improvement of design of water-purification plants. If the designer has a proper understanding of the effective and economical use of structural materials and is well informed on the principles and practice of water purification, and if in addition he can absorb and utilize the experiences of the operator, then the best results will be obtained.

The main elements of a water-purification plant that must be considered in connection with design are as follows: the general plan, chemical storage and application, mixing, sedimentation, filtration, and filtered-water storage. These

will be dealt with in the order mentioned.

A good general plan is of major importance. The arrangement should be as compact as possible consistent with ease of future extension and future elaboration. To this end, the several elements should be arranged to concentrate as far as practicable the control of all elements such as low-lift and wash-water pumps, chemical feed, mixing chambers, sedimentation basins and filters. With a little careful thought it is generally practicable to do this so that the superintendent does not have to walk far from his office or laboratory to check details of operation.

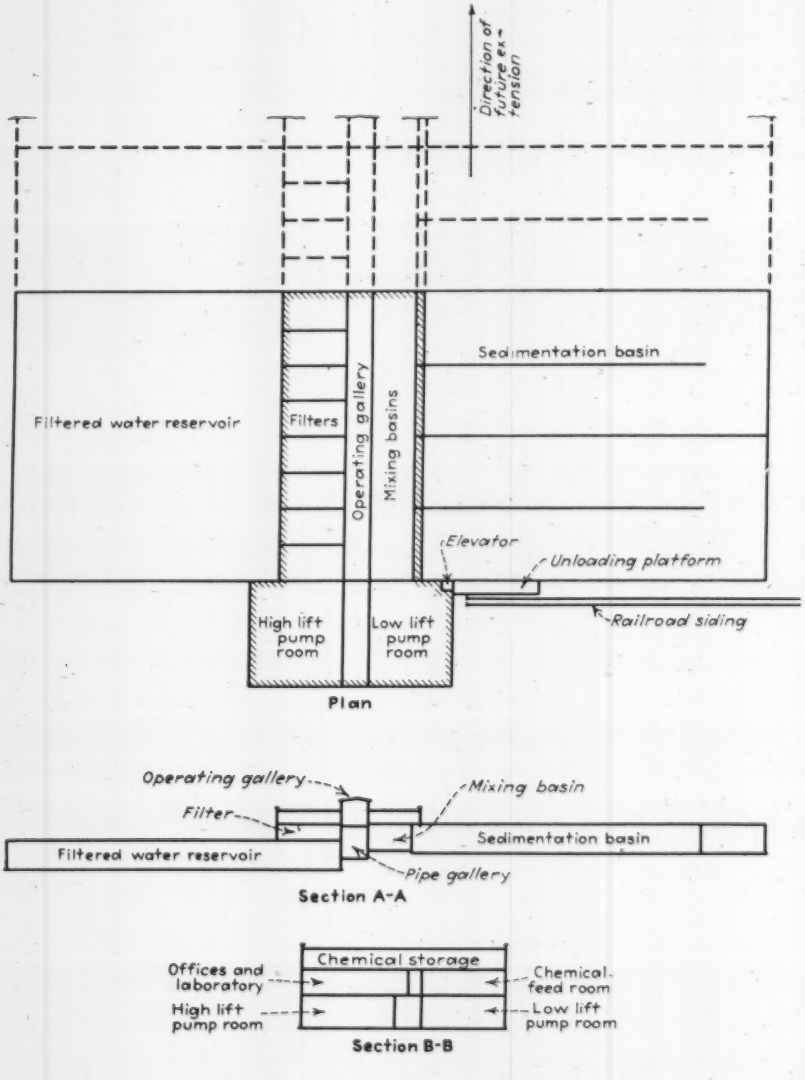
Ease of future extension requires principally that a layout permit doubling or trebling the capacity of the filters and enlarging the reaction chambers and sedimentation basins and the clear-water reservoir more or less proportionally.

The layout should also permit the ready addition of new elements. For example, it may in the future be desirable to introduce softening of the water as a supplement to filtration. This will call for preliminary sedimentation basins equipped with mechanical devices for the removal and the partial return of sludge; also for the installation of recarbonation chambers and an increase in the chemical feed and storage facilities. Some consideration may also properly be given to the future possibility of installing carbon units or zeolite units by way of supplemental treatment.

In designing low-lift and high-lift pumping plants in conjunction with filter plants, it is important to provide liberal space for pumps and piping. A pumping station does not lend itself readily to enlargement, but inasmuch as modern centrifugal pumping equipment takes up comparatively little space, it is often feasible, without undue cost, to design a pumping station in a way that will permit replacement of small pumps with large pumps, to meet any increase in demand for many years in the future; nor is it extravagant to leave space for one or two additional pumps. Pumps should be of sufficient number and range of capacity to permit their operation at maximum efficiency under various conditions of demand.

A general plan, while providing the utmost in flexibility, must avoid any arrangement that may result in pollution of the filtered water. A common fault in the past has been to place the sedimentation basins adjoining the clear-water reservoir with a common wall between them. There is generally a 10-ft. higher water level in the sedimentation basins than in the filtered-water reservoir, and there may easily be unobserved leakage of unpurified water into the clear-water reservoir.

Summing up, the watchwords in devising the general arrangement of a flexible water-purification works are facility in future enlargement, facility in elaboration of processes, compactness and convenience, ready accessibility and observability, and avoidance of any conditions that may jeopardize the quality of the filtered water.



A COMPACT TYPE OF GENERAL LAYOUT which promotes flexibility and facilitates future expansion and elaboration without destroying conveniences of initial arrangement.

Chemical application

The most frequent change in existing filter plants during the past fifteen years has been in connection with chemical treatment. New chemicals have come into use, and new devices for measuring and applying chemicals have been placed on the market. Therefore, it is desirable to provide the operator with as much latitude as possible for changing the chemical treatment. To this end the installation of chemical-feed arrangements should be flexible, but in addition liberal space should be allowed for the addition of chemical-feed equipment and for the installation of temporary tanks and other feed devices for trying out new processes. Often the space allowed for chemical storage and the space allowed for chemical machines has been so restricted that the operators have been handicapped in making changes.

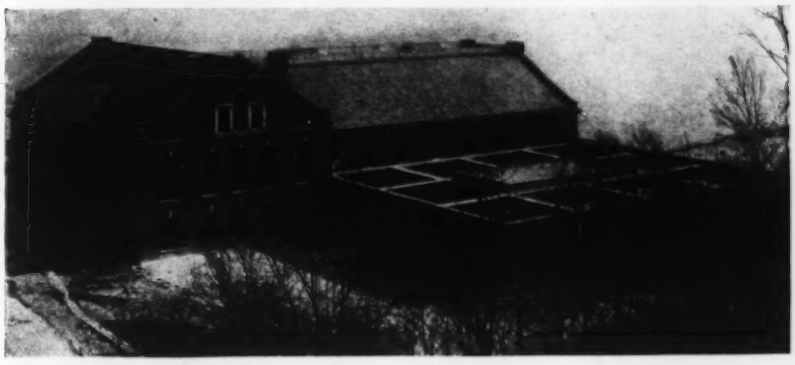
A modern filter plant, especially one dealing with a difficult water, should include chemical-feed equipment for application of several kinds of coagulants. While aluminum sulphate has the widest use, under some circumstances it is desirable to use chlorinated copperas, copperas with lime, ferric chloride or ferric sulphate. Even if immediate provision for all these coagulants is not considered necessary, some latitude for their later use should be provided.

If there is some likelihood that a filter plant may be converted into a softening plant, this may call for either present or future special facilities for handling and storing lime in bulk. Sometimes inert material, such as powdered clay or

silica, is also needed to assist coagulation; generally speaking, such material may be applied through feed machines used for other chemicals. Provision should always be made for the use of lime whether softening is contemplated or not. Lime often assists flocculation, even when aluminum sulphate is used, and is often needed for preventing corrosion and tuberculation. Where lime is applied to both raw and filtered water, however, care should be exercised to prevent a cross-connection between raw and filtered water through the chemical piping.

Taste and odor control is now regarded as essential. Accordingly, provision should by all means be made for the application of powdered activated carbon. This is a troublesome material to handle; it preferably should be stored in a separate, tightly sealed storage space, and feed machines should be in a tightly sealed room separate from the other chemical-feed machines.

More than one point of application of activated carbon should be provided, for it is not always desirable to apply it to the raw water. Sometimes a split treatment may be demanded which calls for at least two feed machines. Sufficient flexibility is provided if activated carbon may be applied to the raw water at some intermediate point during mixing and sedimentation and to the settled water just before it goes to the filters.



FILTER PLANT AT HIGHLAND PARK, ILL., follows the general arrangement shown on p. 634. In the headhouse on the left are the low-lift and high-lift pumping plants, chemical storage space, chemical feed room, laboratories and offices; in the foreground are the sedimentation basins and the aerator with all controls housed in the filter building immediately beyond; in the filter building are filters and mixing basins with their respective controls; beyond the buildings is the filtered-water reservoir. Extension of filters, mixing chambers, sedimentation basins and clear-water storage may be made to the right without destroying the general arrangement.

FLEXIBILITY IS PROMOTED by centralized control in the operating room of the Highland Park filter plant. On left are all controls for mixing and sedimentation, on right are all filter controls. On the other side of the door are the chemical feed room and laboratories.

Mixing

The importance of mixing or gentle agitation of the water after coagulants have been added has become more and more appreciated within recent years. Turbid waters coagulate better than clear waters. During the early days, filtration was applied principally to turbid waters. Consequently, the importance of effective flocculation by special means was not apparent. With rising standards of water quality, filtration is often applied to waters that are frequently clear, such as the waters of the Great Lakes. When clear these waters coagulate with great difficulty and mixing is important. Mixing is helpful in improving flocculation even in turbid waters. The period of mixing is also increasing. Fifteen to twenty years ago 5 to 15 min. mixing was considered sufficient, but now mixing periods are from 30 min. to an hour.

Early mixing chambers were baffled. Under proper circumstances a baffled mixing chamber functions satisfactorily, but within the last ten years there has been a growing preference for mixing chambers equipped with adjustable-speed stirring devices of one sort or another because they give better control than baffles. All authorities are agreed that gentle agitation is desirable, but much remains to be determined with reference to what constitutes the most effective agitation.

Mixing chambers that are provided with vertical stirring devices should always be provided in multiple to reduce short-circuiting. At Winnetka, Ill., and Hammond, Ind., six chambers are used. Chambers are also preferably arranged in two groups so that they may be used independently with either sedimentation basin, thus permitting double coagulation-mixing-sedimentation.

An arrangement of piping, conduits and valves should be used that will permit mixing units and sedimentation basins to be used independently, in series or in parallel, thus permitting any combination of preliminary treatment that may be found desirable.

Sedimentation

The tendency in the design of sedimentation chambers is toward making them steadily larger. At present, a minimum of three hours is regarded as desirable. Sedimentation efficiency has been increased by improved inlet and outlet arrangements, but every operator realizes that the most important and stabilizing element is liberal capacity. Retention periods of as much as eight hours are desirable with many waters, and longer periods can often be justified. In water-softening also large sedimentation basins constitute a stabilizing influence. In the early practice of water-softening, before the introduction of recarbonation, sedimentation basins having retention periods of eighteen hours were regarded as essential. With recarbonation, however, basins of eight-hours' retention have been found sufficient, especially when recarbonation follows short preliminary sedimentation after excess lime treatment.

The studies of H. W. Streeter, particularly on filter plants using Ohio River water, have shown the value of double coagulation and sedimentation. Bearing in mind that the preliminary treatment prior to filtration affects over 90 per cent of the purification, it is desirable to provide operating latitude by having at least two sedimentation basins with accompanying preliminary mixing equipment, arranged so that the basins may be operated in parallel or in series. When operating in series, it should be possible to have single coagulation and mixing or double coagulation and mix-

ing as the circumstances may require.

It has been found practicable in a number of recently completed plants to include all of the mixing chambers and the controls for the mixing chambers and sedimentation basins within the filter building directly adjoining the filter operation floor.

Filtration

The principal item of flexibility to be provided in connection with the filters themselves is with reference to the manner of washing the filters. It has been found that practically all troubles in filters result from the accumulation of solids and organic matter on the sand grains. It is therefore of great importance to provide washing facilities that will keep the sand grains as clean as possible. The importance of keeping the sand grains clean has been brought out principally through the studies of Baylis on the causes of mud ball and cracking phenomena in the sand bed and by the studies of Herring and Hulburt on the use of high rates of washwater. Further light has been shed on this subject by the experiences and experiments of a number of engineers and filter operators, and particularly by the more recent experiments made on surface wash by Baylis.

With a few exceptions there seems to be no doubt that a sand bed can be kept in good condition by washing at a high rate, say up to 42 in. of vertical rise of washwater per minute, the rate varying with the size of the sand grain and the temperature. It appears that good agitation and cleansing of the sand are obtained when the rate of wash is such as to produce a 50 to 60 per cent expansion of the sand grain. There is an element of danger in using a high rate of wash, however, in that it tends to disturb the arrangement of the gravel under the sand, and it also tends to cause mud balls once formed to sink through the sand to the surface of the underlying gravel. These difficulties can be largely obviated by accelerating the application of the water slowly, and also by decreasing the rate of wash at the end of the wash slowly. The first tends to avoid disturbance of the underlying gravel; the latter tends to float all the mud balls to the surface.

Practically equivalent results to those obtained by the high rate of wash can be obtained with bottom wash having a vertical rise of not more than 24 in. per minute, supplemented by a surface wash produced by jets from nozzles placed a few inches above the normal surface of the sand. These nozzles may be placed about 24 in. apart. The water contributed by the nozzles may represent a vertical rise of perhaps 6 to 12 in. per minute, making the total rate of wash, as expressed in vertical rise, not over 30 in. per minute. This results in a saving of washwater, and the evidence indicates that the effectiveness of the wash is greater than with bottom wash alone. Any form of bottom wash, however great, results in some accumulation of mud balls at the surface. With a supplementary surface wash, apparently the mud balls may be obviated altogether.

It is desirable to equip the operating tables with recording as well as loss-of-head gages, and also recording gages for the rate of flow. Sometimes integrating devices are provided to indicate the total flow through the filters. These are desirable but not essential. An operator appreciates a large illuminated dial visible from all parts of the filter room or separate dials on each operating table for indicating the application of washwater in inches vertical rise per minute. In no other component part of a filtration plant has so much thought been given to flexibility of control as in the filters themselves, but still there is much to be learned.

Filtered-water storage

It will generally be found cheaper and more flexible to provide additional filter capacity than a large amount of filtered-water storage. On the other hand, liberal storage of filtered water is always an advantage and is greatly appreciated by operators. Hence, substantially more than theoretical requirements are justified.

Odor-Control Methods Aided by New Test Technique

Intensity of odor of water can now be measured quantitatively by method involving dilution to determine limiting or "threshold" value—Odor characteristics of water supply can be studied on a definite basis

BY M. W. COWLES

Health Officer, Hackensack Water Co., New Milford, N. J.

THE recently developed "threshold" method of quantitative determination of odor intensity provides the waterworks operator with a new tool that is of great benefit in the control of purification processes. Providing an accurate yardstick for odor measurement, it fills a need that has been emphasized by the widespread use of measures for the control or removal of tastes and odors. Standards of quality of public water supplies have been steadily rising, and the use of methods of odor removal has become virtually standard practice today in water-purification plants. The distinct advantage of the new test technique is that, by it, odors are expressed on a quantitative numerical basis and are therefore capable of statistical treatment, giving the plant operator a much more detailed knowledge of the characteristics of the supply and the requirements for proper treatment.

In 1899 the late Professor G. C. Whipple devised a rating scheme for odor intensities. His scheme is now included in the A.P.H.A.'s "Standard Methods of Water Analysis," but it possesses decided defects, largely due to the impossibility of eliminating the personal factor in the determination. In 1931 C. H. Spaulding, at Springfield, Ill., and J. R. Baylis, at Chicago, proposed and developed a method of progressive dilution of the odor-bearing water to arrive at the threshold value of the odor. In 1933 Professor Gordon M. Fair announced a modification of the method by progressive dilution with either air or water, using a constant dilution ratio of 1 to 2. The results are reported in accordance with a scale of pO values.

The method of progressive dilution as proposed by Fair is based on the psychophysical law of Weber and Fechner. This law states that an *arithmetic* increase in sensory-odor intensity corresponds to a *geometric* increase in the amount of odor-producing substance.

Translating this into practical terms, a water with an odor intensity (pO

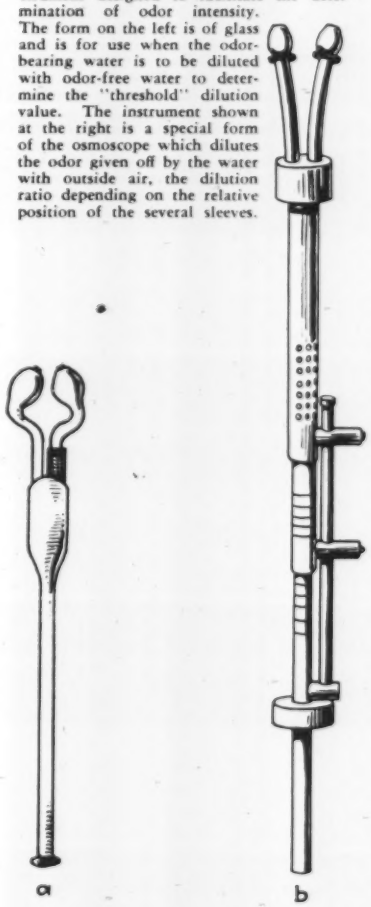
value) of 3 contains twice as much odor-producing material as one with an intensity of 2. If an odoriferous supply of, say pO_4, is diluted with an equal amount of odor-free water (as was recently done with two well supplies in Texas), the resultant pO value will be 3. Treatment with activated carbon might be expected to follow similarly in that each successive increase of 1 in the odor intensity (pO) of the water to be treated would require a doubled amount of carbon to bring the odor down to a given value. This is an assumption, however, that may not be strictly correct, for relatively little is known even yet about the actual physical properties of activated carbon.

A suggested technique for water dilution is as follows:

To a known amount of the water (60 to 200 cc.) add an equal amount of odor-free water; mix and divide into two equal portions, each representing a 1-in-2 dilution. Place one portion in a 500-cc. glass-stoppered Erlenmeyer flask. Dilute the other portion with an equal amount of odor-free water; mix and divide as before to obtain two equal portions, each representing a 1-in-4 dilution. Proceed in this way to prepare dilutions of 1-in-8, 1-in-16, etc., continuing to a dilution in which odor is no longer detectable. Test the highest dilution: first shake the flask long enough to saturate the air within the flask; insert the osmoscope deep into the flask; adjust the movable nosepiece until a comfortable fit is obtained; observe the presence or absence of odor and its character by sniffing lightly through the osmoscope. If no odor is detectable in the highest dilution, examine the lower dilutions until a flask is reached in which the odor is just detectable. If, for example, the flask containing no odor is the 1-in-8 dilution (dilution 3) and the odor appears in the 1-in-4 dilution (dilution 2), the concentration of the odor-producing constituents is 8 times the threshold concentration. In the example the pO value is 3, since three successive dilutions were made ($8 = 2^3$). The pO value then represents the number of times that the sample has been diluted in the ratio of 1 in 2.

The work of Baylis, followed by that of Fair and Wells, has also indicated that more accurate and consistent results in determining odor intensity can be obtained by means of some sort of nosepiece that will fit into the testing flask. The device suggested by Fair and Wells is called an "osmoscope."

The author has made a few tests to compare the results obtained through using: (1) the methods outlined in "Standard Methods"; (2) dilutions in flasks, applying the nose directly; and (3) dilutions in flasks using the osmoscope. The tests indicate that, by the use of the osmoscope, one can detect odor in much greater dilution than is possible by the use of the nose applied directly to the flask containing the diluted sample.



TWO FORMS of the osmoscope, an instrument designed to facilitate the determination of odor intensity. The form on the left is of glass and is for use when the odor-bearing water is to be diluted with odor-free water to determine the "threshold" dilution value. The instrument shown at the right is a special form of the osmoscope which dilutes the odor given off by the water with outside air, the dilution ratio depending on the relative position of the several sleeves.

The successful use of any nosepiece is dependent to a great degree on its fitting into the nose in a comfortable way; otherwise irritation may perceptibly interfere with odor sensitivity. Other precautions are also necessary in connection with the method. It is impossible to get accurate results in a laboratory that is full of other odors. Perhaps special rooms provided with air-conditioning equipment may be desirable. The olfactory nerves can readily become fatigued, and exposure to strong odors increases this fatigue. Also, glass and metalware have the power of accumulating odor substances on their surfaces after continued use; accordingly, all apparatus must be kept clean and free from odor if accurate determinations are to be expected. As a precaution, apparatus when not in use may be kept immersed in tap water containing an excess of activated carbon.

For the diluting water, ordinary tap water can be used that has been rendered odor-free by the use of activated carbon. Tap water properly treated seems to be more satisfactory than distilled water for this purpose.

The threshold method of odor determination may also be used by diluting the odor in the gaseous state with air or an odorless gas, using in this event a special type of osmoscope. The method is, therefore, applicable to all kinds of substances, solids, liquids or gases. It has a very wide application in industrial processes where odor or aroma is an important factor in a product, but even yet its possibilities are only beginning to be realized.

Last year some 325 determinations of cold odor were made in duplicate by the author, mostly on untreated water. One sample was tested by "Standard Methods" procedure, modified by using the osmoscope and an Erlenmeyer flask. The other sample was diluted with odor-free water, and the osmoscope was employed. There was considerable difference between the results obtained by the two methods. A "Standard Methods" rating of 1 may give odor intensities ranging from 0.5 to 5.0, and higher "Standard Methods" ratings also show considerable variation. This discrepancy seems to be due to the presence of certain persistent odors in the original sample, which are masked to a considerable degree by other less persistent odors having lower threshold concentration.

It is possible by the new method to obtain threshold values for the different constituent odors in a single sample. So far, the observations indicate that certain musty and vegetable odors generally disappear at much lower dilutions than do grassy or aromatic odors. Each different water supply will, however, have its own peculiar odor characteristics. The results of the water-dilution method as determined on the same sample of water by different trained observers show remarkably little variation.

In our laboratories the new method is being used on all samples collected from the distribution system where tastes or odors are alleged to obtain. The water supply is filtered and treated with activated carbon and rendered practically odor-free when it leaves the plant. Taking 132 such samples, the results obtained from the odor-determination test are similar to those for untreated water.

The method of progressive dilution to the threshold value, with the use of the osmoscope, allows a waterworks operator to study the odor characteristics of his water supply scientifically, and also enables him to treat the supply with a much greater knowledge of the results to be expected. Odors can be placed on as definite a basis as the chemical or bacterial characteristics of the water and can be subjected to the same type of statistical study, allowing correlation with rainfall, runoff or other factors. The method should be of special value to any supply where industrial wastes are a problem, and studies on such supplies by other investigators are already under way. They give promise of some very interesting results.

Largest Ammonia-Chlorine Plant Installed on Lake Crib

High-capacity sterilization plant built for Chicago requires novel handling, storage and application equipment—Engineer at control station on shore will direct dosage in accord with chloramine residuals at distant pumping stations

BY ARTHUR E. GORMAN, A. H. GERSTEIN AND PAUL H. PETERMAN

Engineer of Water Purification, Sanitary Engineer and Mechanical Designing Engineer, respectively; Bureau of Engineering, Department of Public Works, Chicago, Ill.

CHICAGO now has under construction, with prospects of operation early in July, a new ammonia-chlorine treatment plant, probably the largest of its kind in waterworks and unusual in many features. The plant is being built on the Dunne intake crib in Lake Michigan about 2 miles from shore. It will treat all the water entering the 68th St. and Dunne intakes, averaging 360 m.g.d., with peak periods at rates in excess of 500 m.g.d., which serves the entire south side of the city and seventeen suburban communities —a total population of more than 1,000,000.

The decision to use the ammonia-chlorine process was made primarily in the interest of public health, but it is expected that the benefits to be derived from the treatment will improve operating conditions and prevent objectionable tastes in the water. The process should also eliminate bacterial after-growths in the distribution system.

Studies at the city's experimental filtration laboratory conducted in 1930-31 have proved these advantages of the process. (*Journal* of American Water Works Association, Vol. 23, No. 9, pp. 1334-56, September, 1931.) The studies indicated that there is a marked lag in the bactericidal velocity of ammonia-chlorine, requiring contact of at least 1½ to 2 hours between the water and the chemicals before satisfactory efficiencies are obtained. Longer contact periods result in increased efficiencies. Because of this delayed bactericidal action, the ammonia-chlorine could not be applied at the Chicago pumping stations, since the water reaches the first consumer only a fraction of a minute after leaving the pumps.

By applying the chemicals at the lake intakes, however, advantage can be taken of the time of flow through the tunnels to the pumping stations. Under average conditions the flow from the Dunne Crib to the 68th St. pumping station is 1½ hours, and about 7 hours to the Roseland and Western Ave. pumping stations.

The existing chlorination equipment at the pumping stations is to be maintained to be used in the event of interruption of chemical application at the intake plant and also to supplement, if necessary, the treatment at the intake.

The design of this new ammonia-chlorine treatment plant is quite novel. When the Dunne Crib was designed 25 years ago, no consideration was given to the possibility of its being used as a water-treatment plant. The structure is 107 ft. in diameter, with external walls of steel and stone above the water line. A circular brick building 60 ft. in diameter is built over the intake well. Between the wall of the well house and the parapet wall of the outer crib there was a walkway.

Space on this crib was decidedly limited and in making the plant layout and in the selection of equipment an unusual situation had to be met. In addition, there were difficulties to be overcome due to the exposed location of the crib.

Of special interest in the design are the provisions made for storage space for chemicals and other supplies to permit uninterrupted operation during long periods in the winter when contact with the crib might not be possible. A review of operating records over a long period of years has shown that there have been periods of more than a month when contact with the cribs was impossible due to severe winter conditions.

Floor space for storage was therefore one of the major problems. In order to obtain sufficient floor space, a ½-in. checkered steel floor was placed over the open well of the crib, providing a floor area of 2,000 sq.ft. Another 2,800 sq.ft. of floor area was obtained by placing a

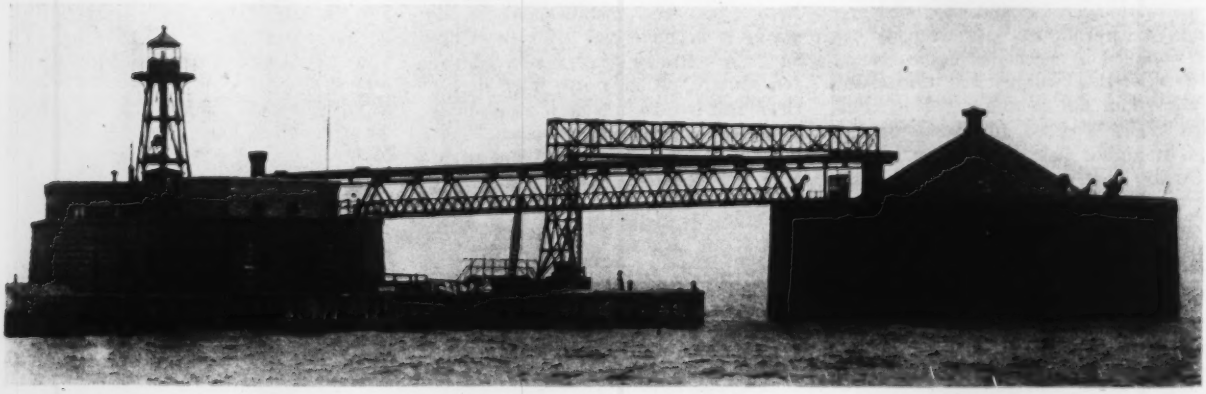


FIG. 1—THE 68TH ST. (left) and Dunne intake cribs supply Chicago's south side. They are connected by a foot bridge and by a crane bridge for unloading 1-ton chlorine containers and other chemicals from material scows.

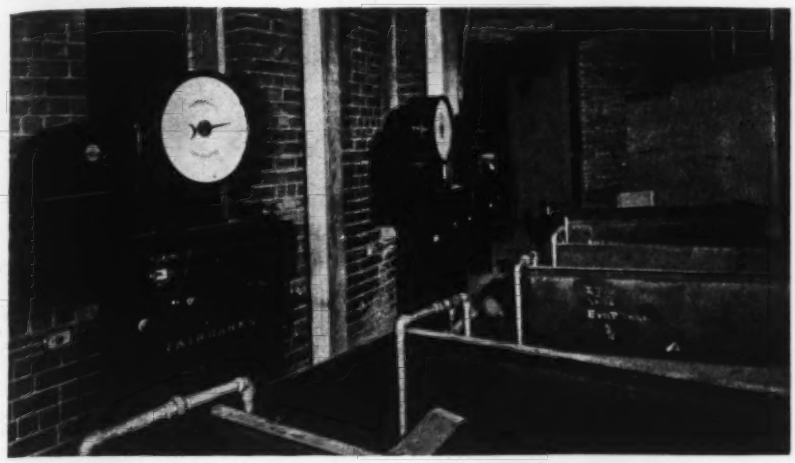


FIG. 2—CHLORINE EVAPORATING TANKS set on recording platform scales. Ton containers of chlorine are brought in on the monorail hoist and lowered into the tanks. In an emergency the exhaust blower shown at the upper right draws air from the scale pit below the tanks. Escaped chlorine passes to the pit through the gratings in the floor.

reinforced-concrete-slab roof over the annular space between the well housing and the outer parapet wall of the crib. This space provided a chlorine storage room large enough to store 40 days' supply, a chlorine evaporator room and a chlorine operating room (Fig. 3).

Ammonium sulphate in 100-lb. paper-lined burlap bags has been decided on as the form of ammonia best suited for use in the plant, both from considerations of economy and ease and safety in handling. Chlorine in ton containers will also be used.

Special chemical scow

For transportation of chemicals a special scow is provided of welded and riveted construction, 100 ft. long and 30 ft. wide. Its deck is fitted with steel saddles for thirty 1-ton chlorine drums and with cargo supports for 39 steel unit containers, each capable of holding twenty 100-lb. bags of ammonium sulphate. The scow also has within its hull valuable storage space for oil and liquid chemicals. There is an 11,000-gal. compartment for carrying fuel oil, which is equipped with electric motor-driven pumps for transferring this oil into storage tanks at the 68th St. crib. Two additional compartments of 8,000-gal. capacity each are provided for the transportation of ammonia liquor, should market prices and operating conditions make its use advantageous.

At the cribs the chemicals will be unloaded from the scow by a 3-ton electric traveling hoist operated over a bridge crane, 100 ft. long, spanning the two cribs. The crane operator in a control booth on the Dunne Crib parapet wall will have full vision and control of the load at all times. After the chlorine drums are deposited on the crib, they will be picked up by a 2-ton electric traveling hoist running on an overhead monorail to the storage room and from there as needed to the chlorine evaporator room (Fig. 2.). The ammonium sulphate bags will be unloaded from the steel unit containers directly onto the floor of the crib. By operating a lever the unit container will overturn and discharge the twenty bags at one time. They will then be transported by hand truck inside the well room and stored on the steel deck.

Chlorine control equipment

At the time the plant was being designed, it was found impossible to use the standard chlorine control equipment available on the market. This was because the space available at the crib was too limited to permit the installation of the number of units deemed necessary for the high rates of chlorine feed required. In consequence, it was decided to undertake the development of high-capacity chlorine-control equipment, which would make the crib treatment plant possible. After much experimental work, a simple and efficient type of equipment for high-capaicty chlorine control has been developed and will be used at this plant.

By this method the 1-ton chlorine container is placed in a steel evaporator tank through which warm water is circulated. The flow of warm water to the evaporator tank is controlled by a diaphragm-operated valve. This, in turn, is controlled by the pressure of the chlorine discharged from the container. When this pressure drops below a predetermined point, the valve opens and allows warm water to flow into the evaporator. When the chlorine pressure rises above the established limit, the valve closes, shutting off the warm-water supply. By this means a fairly constant chlorine pressure may be maintained. By passing the chlorine gas at fixed pressure through a variable orifice, a control of the flow is possible.

The rate of flow of the chlorine is indicated by a rotameter, a relatively new apparatus of much promise in the measurement of gases and liquids. It consists of a vertical, tapered glass tube through which the chlorine gas passes upward. The flow causes a revolving float or "rotar" to assume a position in the tube depending on the velocity of the gas through it. The position of the "rotar" read off the calibrated scale etched on the glass indicates the rate of flow with a high degree of accuracy.

From the variable orifice the chlorine gas flows to an injector where the gas is mixed with water and is then discharged in solution form to the point of application in the intake shafts. All parts of the equipment coming in contact with the chlorine and chlorine solution are constructed of corrosion-resisting materials, such as glass, chemical rubber, tantalum, or metal alloys.

Three rotameters having a capacity of 3,500 lb. of chlorine per day are provided to chlorinate the flow into the Dunne intake, and three having a capacity of 800 lb. per day for measuring the flow of chlorine to the 68th St. intake. Any one of the rotameters is capable of handling the normal range of chlorine feed, so that, in effect, equipment is provided in triplicate, with a combined feeding capacity three times the estimated maximum.

Each of the four chlorine evaporating tanks is mounted on a 10-ton dial-type platform scale. The weighing mechanism is provided with a device that automatically records the weight, time and date on a strip tape at intervals of 15 min.

Two dry chemical feeders, having a range of 20 to 200 lb. per hour are provided for application of ammonium-sulphate to the Dunne intake flow, and two smaller feeders, having a range of 1 to 50 lb. per hour are provided for the 68th St. intake. The large feeders are located in the well room on a subfloof with openings to the 50-cu.ft. hoppers on the main operating deck. The small feeders have hoppers of 4 cu.ft. capacity each. Each of the feeders is suspended on a dial-weighing scale provided with a strip-chart recorder. After the ammonium-sulphlate is measured, it will be dissolved in a solution pot, from which it will be ejected through a rubber hose to the points of application in the intake shafts.

To obtain a thorough mixture of the ammonia with the water before the chlorine is applied, the ammonium-sulphate solution will be applied to the water in the uuper portion of the intake shafts, while the chlorine solution is applied near the bottom of one of the shafts. The ammonia and chlorine solution lines for applying the chemicals to the 68th St. crib intake water are carried over to the crib through an insulated wooden conduit box fastened on top of the connecting foot bridge. The steam, condensate return and water lines are also carried through the conduit.

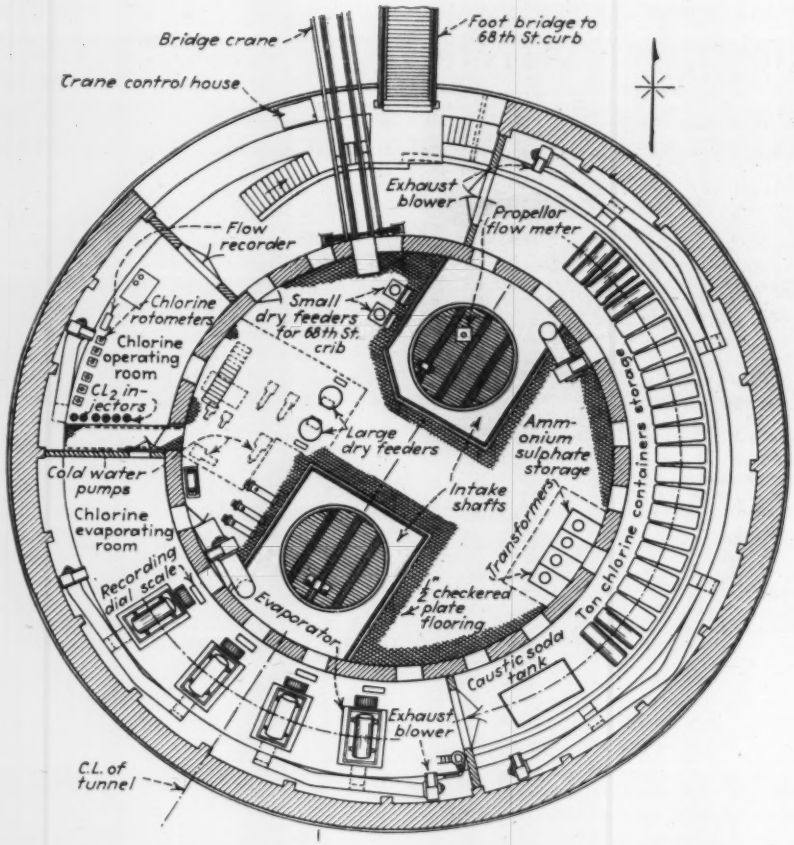


FIG. 3—AMMONIA-CHLORINE TREATMENT PLANT on Dunne Crib. Chlorine operating and storage space are provided in the annular-shaped room, and ammonium-sulphate and miscellaneous equipment are housed in the central circular space over the intake well.

Electric power for operating the equipment is furnished through a submarine cable from shore, carrying 2,300 volts, to four transformers mounted on the crib. These transformers reduce the voltage to 230 and 115 volts for the power and lighting circuits, respectively.

The water supply to the injectors and for other purposes is furnished by duplicate 300-g.p.m. centrifugal pumps operating against a 165-ft. head. These pumps are set on the lower platform and draw suction direct from the well. They are primed compressed-air inductors. An air connection is provided to an outer casing over the pump suction, for the purpose of bubbling air around the suctions during extreme freezing conditions in order to prevent formation of ice.

Duplicate boilers, oil burners, fuel-oil tanks and accessory equipment are being installed on the 68th St. crib. They will furnish steam for heating both cribs and for the water heaters, which provide the warm water to the evaporators and temper the injector water supply.

As a protection in case of chlorine-gas leakage, each room is provided with suction blowers and ducts which discharge outside the crib and are capable of making a complete air change every minute. An additional protection is a steel tank containing sufficient caustic soda (20 percent) to absorb a ton of chlorine. The soda tank is located between the chlorine storage and evaporator rooms. In case of a serious leak in a ton container, it may be placed in this tank and the leaking chlorine absorbed. The operating crew will be quartered on the 68th St. crib, where complete sleeping and eating accommodations are provided.

To maintain close supervision over the treatment at the cribs, a control station will be established on the lake shore adjacent to the 68th St. pumping station. Here a trained engineer will be on duty at all hours, day and night. A 15-wire submarine telephone cable has been laid on the lake bottom from the control station to the Dunne Crib. Over this system orders will be transmitted to the operating staff on the crib regarding rate of feed of chemicals. The effectiveness of the treatment will be checked by hourly residual chlorine tests by the control engineer. He will also receive reports from the three south side pumping stations in regard to the residual chlorine in the water reaching those points.

It is important that some means of obtaining accurate information of the instantaneous rate of flow through the lake tunnel be provided so that the chemical feed may be applied in proper proportion to the flow. A 36-in. propeller-type meter was installed about a year ago in one of the intake shafts in the Dunne Crib. It will be used to measure and record the flow into the intake on instruments located in the crib chlorine operating room and in the shore control station. This duplication of records at remote stations is obtained through a Selsyn system over the wires in the submarine cable.

The project was carried out under Oscar E. Hewitt, commissioner of public works, and Loran D. Gayton, acting city engineer. It is desired to acknowledge the cooperation of O. B. Carlisle, engineer of waterworks design, under whom the structural and mechanical design was caried out; J. J. Versluis, engineer of waterworks construction; and Ernest Stromback, assistant engineer, the latter being in charge of the construction work.

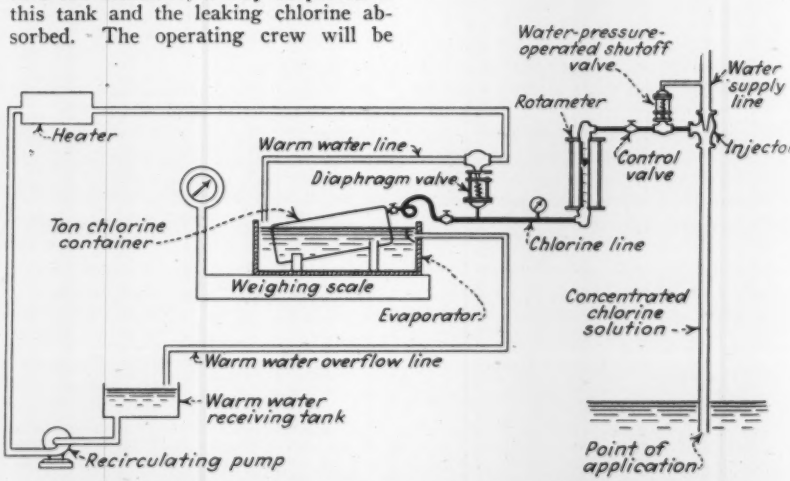


FIG. 4—SCHEMATIC DIAGRAM of the high-capacity chlorine-feeding equipment. Automatic control of recirculating warm water maintains constant pressure in the chlorine container.

WATERWORKS ADMINISTRATION

The Limits of Economy in Operation of a Water System

Economy in waterworks operation must not be carried to the point where it becomes parsimony, for adequate service must always be maintained, including unquestioned purity of the supply and the provision of pressures and quantities to meet legitimate demands

Meters and Meter Records Present Economy Opportunities

BY A. S. HIBBS

Superintendent, Dept. of Waterworks, Cincinnati, O.

OFTTIMES the personal element in waterworks operation is allowed to expand in one direction to the exclusion of other necessary features, resulting in an accumulation of records or of complicated working processes that overshadow the entire organization.

In meter-testing equipment it is possible to install complicated and expensive scales, tanks, weirs and other measuring devices that run into thousands of dollars, and then have the entire set-up become obsolete because a change in policy provides that large meters be tested at their regular location. Such large equipment can also be displaced if it is decided to test only at certain maximum rates of flow, which can be provided by much more simple means.

In smaller meters it is possible to overrate the value of removing and testing meters either at short stated periods or following stated periods of recorded consumption.

It is just as bad to install meters of questionable quality, merely on a price basis, and then never test them for accuracy or registration on minimum flows as it is to expend good money for high-priced meters on arguments of long life, continually to take them out for testing and inspection and finally to maintain endless records of such tests. This procedure would seem to represent two extremes of bad practice.

Another economy that would appear to be misplaced effort is continually to repair and rebuild types of meters which long ago were obsolete in what we now consider the function of a water meter. Modernized homes in which old fixtures have been replaced and new ones added call for meters larger in capacity than some of the older types. Meters can now be obtained at moderate cost which will supply this needed greater capacity, so that in most cases it is far more economical to replace the older obsolete types than continually to spend money to repair them.

In the collection divisions of the modern waterworks, it is possible to combine and simplify records to an amazing extent. Former bookkeeping methods led to the duplication of records, which in many cases meant nothing at all in the final analysis of accounts.

Meter-reading records can be used as the full record of a customer's account, showing in many cases original entries that are invaluable in cases of water-bill disputes. Many duplicate copies of on-and-off orders can be used in various divisions of the department as work

orders and final records of the condition of a customer's service branch. Likewise orders for the installation of services can be made parts of the permanent record without recopying.

Considerable duplication in records of permanent installations of water mains may be avoided if standards as to size of drawings, standard symbols, titles, numbering and lettering are adopted from the very beginning.

The field of simplification and coordination of forms and records in water department practice is one that can effect immense economies in waterworks practices.

True Economy Demands Weighing Improvements Against Possible Gain

BY THEODORE A. LEISEN

Secretary and General Manager, Metropolitan Utilities District, Omaha, Neb.

IN THE PRESENT unbalanced condition of affairs throughout the country, with the trend toward increased costs of labor, materials and supplies and with the prospect of diminution in the financial returns of most public utilities, it seems opportune to discuss briefly the possibilities of greater economy in operating waterworks systems.

True economy may be defined as that method of operation or construction that will produce the desired results with the minimum of expense consistent with the maximum of efficiency. However, in interpreting this definition, economy must never be confused with parsimony. In the realm of water supply this principle should be acceptable as axiomatic, since achievement of the desired results always means that only the best attainable results can be acceptable in the bacterial purity of the water.

Water purification is essential for all surface supplies, and filtration plus chlorination is the standard practice. But filtration has passed the experimental stage, and it seems questionable whether large sums of money and years of time should now be devoted to such experimental work. Probably, *political* economy might apply in these cases.

In the operation of filtration plants some simplification of records and curtailment of some chemical determinations might be practiced to advantage. Then, too, the U. S. Public Health Service might use more discretion and common sense in some of its demands, all in the interests of economy.

On other points in waterworks operation the desired conditions may be balanced against the cost of attaining them, and a line drawn between the desires or demands of certain individual industries or certain sections of a city or town and their actual normal necessities. For example, greater pressure or greater quantity for short peak periods or for sprinkling service may be desired, but need not be essential. Softening of a city's entire water supply might be of considerable benefit to a limited number of consumers and for a small percentage of the total consumption. The economics of this situation should be carefully scrutinized before embarking on a project that may entail considerable construction cost as well as continuous operating expense.

Adequate equipment for an ample and continuous supply of water for fire-fighting purposes is a requisite condition of every waterworks system. While the Board of Fire Underwriters deserves great credit for the work carried on under its supervision or advice, the somewhat selfish interests which it represents, backing their recommendations with the threat of increased fire insurance rates, frequently call for expenditures that a more disinterested and saner course of reasoning and due regard for economy would modify.

In regard to meters, the economics of the situation should decide the question of whether or not to install them generally. However, it can be said that no city that has its consumption 100 per cent metered would ever consider reverting to the flat-rate system. Where the danger of a shortage of supply is imminent, meters should be installed to prevent waste. But where an unlimited supply is available, the economic problem will be whether to suffer the expense of excessive pumpage to provide for wasteful use, or to expend the money required for meters.

Expert accountants and efficiency experts have improved accounting systems in many instances, but a word of warning may not be amiss in suggesting some hesitancy about abandoning or exchanging an existing system of bookkeeping, recording and general accounting, without full investigation and mature consideration. Occasionally an expert system of checking, billing and accounting will cost more in operation than the saving that could be effected would justify.

Economy in construction operations should not be ignored, but it is not so essential here as it is in operation, because only the interest and depreciation on the excess construction cost counts in the future. Furthermore, ample reasons exist for giving full scope to architectural or esthetic beauty in any municipal structure, and this may result in a higher cost than adherence to a strictly economical plan would warrant. Parsimony should not be substituted for economy, and it would be parsimonious to erect an unsightly building where beauty of form and line should exist.

In the field of operation every effort should be made to obtain the maximum of efficiency at the minimum cost. Here the man in charge must have full control, unhampered by political interference, and he should have the cooperation of his entire organization. Not one more employee should be on the payroll than is needed, and not one less than is essential for efficient service. All should receive compensation commensurate with their respective duties. To effect economy by reducing wages is inexcusable when there are more legitimate ways to accomplish the desired result. Perfect coordination of all heads of departments is imperative, as only by united effort can economy be achieved. The purchasing department, the distribution management and the pumping station operators all should be potent factors in the production of the desired results.

It seems almost futile to refer in detail to the methods for carrying out this plan, but a few suggestions may be pertinent. In the purchase of materials and supplies, fair competition always should be obtained, and the markets should be watched so that supplies can be laid in when prices are lowest. This procedure applies with special emphasis to steam coal, the price of which invariably undergoes rather wide seasonal fluctuations.

In the pumping of water it will be surprising to find how much saving can be effected by careful, intelligent attention to minor details, particularly in the boiler house. Keeping close watch on the coal, ash and the boilers in general, and having each shift vie with the others in friendly competition will fully repay the effort. As an example of what has been accomplished by following these plans, the records of one municipal waterworks are as follows:

	Pumpage in M. G	Cost of Fuel	Coal Used, Tons
1923	9,281	$148,257	30,825
1930	10,558	98,629	26,970

This record is given to 1930 because subsequent to that year part of the pumpage was done by electricity. Another record for a ten-year period is as follows. In 1923 the cost per 1,000 gal. was 4.5c., and in 1933 it was 3.4c., or 24 per cent under the earlier figure. In these cost figures all labor incidental to pumpage is included, and it should be noted that salaries and wages were generally increased during the ten-year period.

Water-Revenue Diversion A Dangerous But Common Practice

In time of financial distress many cities have used the revenues of their water departments to support other municipal functions, thereby crippling operation, maintenance and necessary improvement of their water-supply systems

Water Purity Endangered by Diversion of Water Funds

BY GEO. N. SCHOONMAKER
Director of Public Service, Toledo, Ohio

WHEN the present administration assumed control of the municipal waterworks of Toledo, Ohio, in January, 1934, there was less than $25,000 in cash in the water fund, although book balances showed that there should have been a cash surplus of more than a million dollars. The book balances were there, but the money had been used to support other city functions during the recent period of financial misfortune. The immediate problem was one of determining the exact condition and completely revising financial policies to prevent further diversion of water funds to uses other than the waterworks.

In 1931 practically all the banks in Toledo closed, impounding all city funds then on deposit, including the funds of the waterworks. These were not released until 1933 and 1934. During the intervening period fund balances were maintained, but when the impounded funds were finally released their allocation to specific funds was extremely difficult.

Shortly after 1931 the full force of the depression struck in Toledo, and funds to operate the municipal services were extremely short. In accordance with its practice of long standing, the city maintained but a single bank account, and when payrolls were to be met a large overdraft in the general fund was incurred by borrowing from other funds. Among these was the waterworks fund and during this time the waterworks cash was practically depleted.

City issues indebtedness certificates

Another incident that reduced the cash surplus of the water fund occurred in 1933. The city, to meet payrolls, issued certificates of indebtedness (scrip) because all its cash was exhausted. These certificates were accepted by the city in payment for all municipal obligations, including water bills. To obtain cash, employees transferred their certificates to water users, who turned them in to the collection department in payment for water bills. The water fund absorbed about a million dollars in certificates in that way. Of course, when these certificates are paid off by the city, the water fund will be reimbursed. This practice, however, had one particularly serious effect. Cash in the water fund was depleted as fast as it was received, and not enough money was permitted to accumulate to buy water-purification supplies.

Policies reversed

In 1934 these policies were completely reversed. Fortified by a court decision rendered in January, 1934, ordering waterworks funds to be held in a fund on deposit entirely separate and distinct from all other city funds, the cash surplus was allowed to grow and accumulate. Acceptance of city scrip was stopped. Since January, 1934, the waterworks cash surplus has grown from something like $25,000 to about $250,000, and by the end of 1935 we expect to have approximately $400,000 in reserve.

Under both the constitution and the statutes of Ohio the municipal waterworks is placed in a peculiar position. The city's function in operating and maintaining a water-supply system is essentially of a private or proprietary nature. It is not mandatory on the city to engage in the business of water supply, but under the law the city is granted permission to engage in it if the citizens so desire.

Owing to this private nature, the water fund must receive compensation for water service rendered, regardless of whether such service is rendered to another governmental unit or to private individuals or corporations. That the waterworks is owned and operated by the city in no way alters the situation. Furthermore, the waterworks fund cannot be used for any purpose except the maintenance and extension of the waterworks system. Thus, waterworks funds cannot legally be diverted to the general fund except as a charge for services rendered by other city departments.

Charges for engineering service

The practice of billing the waterworks for services rendered has reduced the waterworks cash surplus materially in the past. For example, in 1930 the waterworks was charged $75,000 for technical services rendered by the engineering division. The total annual appropriation of the engineering division at that time was slightly more than $150,000, so that the water fund supported about half of this entire activity. This charge was based on an estimate that the engineering services rendered to the waterworks had a value equal to 12 per cent of the total waterworks payroll.

Many other instances of diversion could be cited which, over a period of several years, reduced the water funds to a great extent. The propriety and the reasonableness of such charges are matters of some controversy.

Single city bank account

As has already been pointed out, in Ohio the waterworks funds are legally separate and distinct from all other muncipal funds. In Toledo this has been carried out in theory but not in practice. For a number of years Toledo has maintained a single bank account for all municipal funds and has deposited cash in this account as received. As money was received from some specific source, the amount was credited to the appropriate fund and the cash deposited in the one bank account.

This practice has been a matter of discussion for a good many years by students of public finance. Some hold that a single bank account is sufficient if a bookkeeping and accounting system

is maintained, which will show at any given period throughout the year the exact condition of all funds in relation to the cash on deposit. Others argue that each municipal fund should be a separate account. There are meritorious arguments on both sides. However, our experience in Toledo over the last five or six years indicates that the practice of keeping separate bank accounts is necessary if the funds are to be conserved.

In Toledo we have made a complete circle of waterworks financing. Practically all diversions that were made in the waterworks funds have been for the operation of other municipal services. The most serious consequence of such diversion was the inability of the city on several occasions to purchase necessary supplies for water purification. The hazard thus presented needs little explanation, for it is apparent that even one day of impure water would have disastrous and widespread effects on the entire city at large. Happily this situation did not occur, and we are now on the road to proper handling of the water funds, keeping them intact and permitting a surplus to accumulate. This is the spirit and letter of the constitution and laws of Ohio.

Water Funds Widely Used to Supplement Tax Revenues

BY N. T. VEATCH, JR.

Consulting Engineer, Kansas City, Mo.

DURING the depression years the practice of transferring funds from municipal utility departments, particularly waterworks, and using these funds for the payment of general municipal expenses has become rather common. The inability, or failure, of these cities to collect taxes has left their general funds so depleted that only by borrowing from banks or by transferring funds from other accounts could the salaries and other current expenses of the city be paid. The ultimate effect upon the financial program of the municipal utility is given but little consideration by the city governing body when faced with the necessity of finding funds to meet current expenses, particularly if the utility has a balance in its depreciation or sinking fund.

Diversion in typical cities

Prior to the depression period, state statutes generally forbade the transfer of funds from one department to another, but with the decreasing of revenues from taxes and the increasing demands for funds for relief uses, the tendency has been to change the statutes to permit diversion.

In Kansas the law permitting transfer of funds was passed in 1933. In that year at Topeka there was transferred from the water department fund $8,654, while in 1934 $15,832 was transferred.

At Tulsa, Okla., out of a total gross income of $3,314,672 from water department operations in the four-year period ending June 30, 1935, $2,070,284 has been diverted to other city departments, leaving only $1,140,816 available for operating and maintenance expenditures. Only $103,572 has been expended for improvements. That a water department having a plant investment of more than $12,000,000 and serving a city of 150,000 population can continue to function at all under such reduced expenditures for operation and maintenance speaks eloquently of the managing ability and devotion to duty of the department's officials and operating heads. It is apparent, however, that continued operation on such an extremely meager expenditure for maintenance can result only in progressive impairment of service due to the cumulative effects of deferred maintenance.

At Shreveport, La., a city of 85,000, the municipal water department has been forced to turn over to other departments in the past three years a total of $225,000. The loss of this sum to the water department has meant the necessity of reducing maintenance expenditures to an absolute minimum and the deferring of much-needed improvements and main extensions, which, if they could be made, would provide water service to additional prospective users and bring additional income to the department. Thus, the candle is being burned at both ends.

At Flint, Mich., a city of 167,000, the effect of the depression in causing diversion of waterworks revenue to other uses is quite clearly shown. In 1929 the payments for hydrant rental to the water department, amounting to $110,000, was discontinued. In 1932 the cost of operating the sewage pumping station and disposal plant, amounting to $50,000 per year, was charged to the water department. In 1933 a meter license tax amounting to $60,000 per year was placed on the water department. These constitute a total diversion of $220,000 of water revenue per year to other city activities. In 1934, in an effort to reduce ad valorem taxes, the state of Michigan enacted a law limiting the assessment for such taxes to 15 mills. Flint, being a home-rule-charter city, adopted by popular vote the same restriction on its tax levy. This brought about a search for other revenue to replace the loss in general taxes, and resulted in the transfer of an additional $125,000 from the retirement reserve fund. In this instance both the city officials and the management of the department realize the danger in the diversion of funds from the water department, and consider it an emergency practice only.

Diversion unfair to taxpayer

The diversion of funds from municipal income-producing utilities, to maintain the service and other governmental activities, may be considered as an unfair and unjust practice, not only from the viewpoint of the utility user but also from the viewpoint of the taxpayer. If the revenue of a municipal water department is sufficient to meet all department costs, including operating and maintenance expenditures, depreciation allowances and debt-service charges, and leave a balance available for transfer to other departments, then the water user is paying too much for the service he gets, and the rate schedule should be reduced. If, on the other hand, the revenue of the water department is taken over by other municipal departments normally supported by tax revenue, leaving the water department with insufficient funds to meet its reasonable depreciation and debt-service charges, then the practice is unfair to the taxpayer, who must be called upon later to furnish funds through taxes to pay these charges.

If a municipal utility, or a private utility for that matter, is to function properly, and continue to do so over a period of years, it must adhere to a very definite financial program. Its revenue from the sale of its commodity must be sufficient not only to meet its current operating expenses, including proper maintenance, but also to provide a reasonable fund from which the expense of replacing worn-out equipment and the construction of improvements can be met, and the interest and retirement charges on the bonded debt of the department be paid as they become due. This financial program should be very carefully planned, covering a five-year or longer period, and should budget the expected income and expenses, including depreciation and sinking-fund charges for each year. Such a budget scheme has been worked out in a number of cities and is operating in a satisfactory manner. It would seem that the use of this plan would serve to discourage the diversion of funds to other departments.

It is to be hoped that municipal governing bodies can and will become so thoroughly informed as to the necessity of setting up and maintaining a proper financial program for their municipal utilities that the diversion of funds to support other municipal departments will no longer be countenanced.

Waterworks Operation A Problem Dependent on Personnel

Capable waterworks personnel is the first essential of proper water service—The establishment of schools for waterworks operators and regulations requiring examination and licensing to attest training are steps looking toward a more attractive career service

BY HARRY E. JORDAN

Chemical Engineer, Indianapolis Water Co.; and President, American Water Works Association

WHAT VALUE is there in a fine waterworks system or a new filter plant if it is staffed by incompetent men who do not know from one day to the next when the political axe will fall?

In the water-supply industry, which, in the case of nearly 80 per cent of the urban population in the United States, is controlled by municipal governments, it is a shameful fact that training and real adaptability for the work too rarely lie back of appointments. The "home rule for cities" doctrine is overworked to the end that as many positions as possible, even technical, shall remain stakes in the political chess game. State engineers and forward-looking waterworks men have realized that some steps must be taken to make sure that at least those men charged with the operation of purification plants shall meet certain minimum standards as to training and knowledge.

Licensing purification-plant operators is not a mere subterfuge to keep present incumbents safe in their employment. The underlying idea is, and it should be thoroughly understood to be, the coordinated training and demonstration of fitness on the part of plant operators. That this fitness should be demonstrated by an initial examination is not enough. Periodically it must be confirmed by further study and re-examination.

That makes plain the field of waterworks operators' conferences or schools. Water purification is not static. Fuller at Louisville, Ellms at Cincinnati and many others years ago demonstrated the basic principles of the art, but since then scores of men have shown new factors in its application and continue to discover new methods of ensuring safety and palatability for our cities' drinking-water supplies.

The state waterworks schools are the link between local and nationwide progress, for through these schools men in the smaller communities have learned of the means that are at their command to render better service.

The combination of licensing and waterworks schools, on the one hand, trains men for the improvement in water-supply service for which every city and state should strive, and on the other hand assures to waterworks personnel the degree of security and community respect to which any hardworking willing employee is entitled. The progress made in this regard is shown by the table below.

A most wholesome movement has taken form in Georgia, where, although neither law nor state regulation requires filter operator's examination and licensing, a voluntary agreement exists by virtue of which the majority of operators have undertaken certain studies and submitted themselves to examination.

In West Virginia there exists perhaps the best combination of forces. There the state sanitary engineer joins hands with the engineering staff of the state university and the operators themselves in administering the regulations of the state health department. The valuable feature of periodic re-examination is also in effect. We all know that the great fault of civil service is that it makes ruts safe for the lazy. Career service demands that a continued state of efficiency be demonstrated.

WATERWORKS OPERATORS' CONFERENCES AND LICENSING REGULATIONS

Ala.	A	B	D	Neb.					
Ariz.				Nev.					
Ark.	A			N. H.					
Calif.	A		D	N. J.			B	C	D
Colo.	A			N. M.					
Conn.		B	D	N. Y.	A				
Del.				N. C.	A*				
Fla.	A*			N. D.	A				
Ga.	A		D	Ohio	A			C	D
Idaho			D	Okla.	A				
Ill.	A	B		Ore.					
Ind.	A*			Pa.		A	B		
Iowa	A			R. I.					
Kan.	A		D	S. C.					
Ky.			C D	S. D.					
La.		B		Tenn.	A				
Maine		B		Texas	A*				D
Md.				Utah					
Mass.				Vt.					
Mich.	A		C D	Va.	A*				
Minn.	A			Wash.					
Miss.				W. Va.	A*			C	D
Mo.	A	B		Wis.	A				D
Mont.	A*			Wyo.					

NOTES:

A—States in which an operators' school or conference has been organized—generally by state sanitary engineers. States marked *A** are those in which such schools are directly affiliated with AWWA sections.

B—States in which there is an independent water supply or utilities association.

C—States in which there is legislation establishing qualifications for filter-plant operators.

D—States in which there are state health department regulations controlling filter-plant operators' qualifications.

In Illinois another movement is growing rapidly under the name of The Illinois League of Municipal Public Utility Employees. Its major project is the creation of age and retirement funds. It unfortunately subordinates in its concern the value of training and experience and the fact that both are essential to successful operation of municipal utilities. It does offer, though, an opportunity for men in all branches of state and municipal technical service to organize and meet upon a common ground to study their problems.

The organization of waterworks and the licensing of filter-plant operators are wholly worth-while activities. But there should be no illusions about the situation. Filter-plant operators are only a part of waterworks personnel. If there is a single titled position in a water plant that is not better filled by a trained and experienced man, it should be abolished. And the whole thesis is that training and experience and continued ability to serve deserve repayment in terms of continuity and security in service.

The extension of governmental control of activities formerly privately managed unfortunately has not been combined with a corresponding extension of efficiency qualifications for personnel. But there is evidence that realization of the danger is becoming widespread. Thus, the fact that in a field of public service so widely municipally controlled as its water supply the steps being taken to secure and retain the services of more adequately trained personnel should also indicate that the fullest return from these activities will be obtained by joining with similar movements in affiliated fields. Water-supply personnel selection may perchance lead the way to more intelligent personnel selection in other fields of public service.

Urban America of today and tomorrow must have skilled men in its service departments if our city life is to be bearable. And the creation of a public interest in and support of the retention of skilled men in government is a problem that calls upon waterworks men to unite their efforts with those of any intelligent organization engaged in attacking the same broad problems.

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May 2, 1935

Beltsville as a Warning

FIRING the chief of the Bureau of Animal Industry for mismanagement of construction at the Beltsville, Md., experiment station of the U. S. Agricultural Department is of small consequence as long as the system under which he directed a vast construction program remains. Beltsville is an outstanding example of the waste, mismanagement and inefficiency resulting from attempts of government bureaus inexperienced in the management of highly complex construction programs to undertake such work by day-labor methods. An inquiry, begun after charges had been brought by the Associated General Contractors of diversion of funds, violation of laws and wasteful incompetence, has now led to the dismissal of the official who had charge of construction. But this example of incompetent wasteful procedure should also remind all government officials that only rarely can day-labor work be conducted with the efficiency and economy of contract construction.

New Incentive

WITH THE REOPENING of the PWA application file, a new incentive is held out to the many communities which developed promising programs of local improvement work under the stimulus of the recovery drive initiated by the 1935 act, only to be disappointed by finding the list closed before their projects could be considered. The new money made available by the relief works act will enable the most urgent of these projects to go forward, and this opportunity is an encouragement to progressive community action. There is a double reason for pushing these projects with energy: to take care of the community's employables, and at the same time to build for better community service and facilities. In addition, there is a supporting reason for undertaking these projects that should not be left out of view. It lies in the fact that resumption of normal improvement activities would be a major step in the city's return to the basic policy of independent, self-reliant development—the surest guarantee of growth and prosperity.

Sound Business

FROM THE SAME VIEWPOINT of helping the cities to get back to a sound business basis, it is interesting to learn from Washington advance rumors that greater reliance may be placed on service revenue bonds to secure PWA loans. In the administration of the $3,700,000,000 emergency appropriations of the past two years, revenue bonds were treated with distrust, and general obligation bonds were demanded. The cities were thus placed at a direct disadvantage in getting needed improvement projects started, and at the same time they were encouraged in the unbusinesslike practice of diverting service revenues, such as those earned in waterworks operation, and using them for general administrative purposes. If revenue bonds are raised to a deserved position of recognition, a strong impulse will be given to the movement of placing departmental service administration on a sound business basis, with proper accounting of costs and revenues, and with service income strictly segregated for use in maintaining the service itself.

What's in a Name?

THE PROPOSAL to change the name of the Interior Department to Department of Conservation and Works is the outward representation of a reform that has been under active discussion for more than a decade. Under its old name the department has ever been a convenient repository for activities that seemed to find no other natural home. On the other hand its major function of dealing with national resources and development was often overlooked, and such activities as those of forest conservation and road construction were placed in other departments. The name Conservation and Works can hardly fail to be a means of concentrating in this major branch of the governmental establishment the important development activities carried out by the nation for its peacetime purposes. Engineers have come to recognize the advantages of such governmental simplification. The reasons for it grow stronger with the passage of time, and they have been reinforced by the creation of the National Resources Board, which brought the Interior Department into close contact with the essential problems of planning development projects on a long-time basis. A governmental unit dedicated by its very name to the planning and execution of works to conserve our resources and improve the nation's physical equipment would tend toward efficiency and economy.

Roadwork by Roadbuilders

ADVICES FROM WASHINGTON indicate that both the highway industries and the road-using public may have an easy mind in respect to the handling of the roadbuilding millions of the relief works act. The Bureau of Public Roads and the state highway departments, with which highway users and roadbuilders have always done business, will continue to be the agencies directing the operations. This applies to the new activity of railway grade-crossing improvement, which is now definitely placed in a division of the Bureau of Public Roads, as well as to the types of highway improvement to which former federal highway grants have been particularly directed. The decision to entrust the established agencies with grade-crossing responsibility is well advised. It places the vast new work in the hands of a going organization that during depression has expeditiously performed federal roadwork costing over three-quarters of a billion and is now at the highest point of its directing ability and working efficiency. It gives assurance, too, that the construction practices and labor requirements to which the highway business has been adapted will not be radically changed, and that therefore the work can go forward promptly, without disruption or mischance. Highway work to give employment and create new paths for highway transportation development has received an impulse to greater speed and efficiency by the confidence which the Washington administration has shown in its ability to perpetuate its past four years' extraordinary performance records.

Our Decaying Plant

IT IS A MATTER of common knowledge that the country's necessary productive plant has been undergoing an abnormal deterioration during the last few years. Great losses due to both mechanical wear and to obsolescence have occurred, but unfortunately no measuring stick for these losses was available. Now comes a significant index of the extent to which our productive plant has decayed as the result of stagnation, in the form of a census and inventory of the machinery industry's production equipment by *American Machinist*.

Beginning in 1925 and repeating its undertaking in 1930, that journal took a census of the equipment of machinery-building establishments. In 1925 it found that 44 per cent of all the machines in these shops were ten years old or more—a figure taken as a fair measure of life of the tools, whether rated on physical condition or on economic life (ability to stay in competition). By 1930 this percentage had not changed materially, the obsolescence percentage found in that year's census being 48 per cent. The 1935 census, however, shows that obsolescence has reached the figure of 65 per cent.

Let it be remembered that this figure is determined by age statistics alone, while other factors also contribute to loss of productive value. Rapid improvement of processes, introduction of better cutting steels, and like advances contribute to shortening economic life. The progress made in these directions during the past decade suggests that the machinery industry's productive plant may have deteriorated even more than the change from 44 to 65 per cent would suggest. It is perhaps no exaggeration to say that, in terms of useful modern equipment, fully half the value of the industry's machine plant has been lost since 1925.

This is a tangible measure of the depression's effect in destroying direct working capital. The figures provoke serious thought. They forecast the need for large expenditures to reequip within the next few years. It is not an indictment against the machinery industry, however, that it allowed this heavy deterioration to go on, for in a time of slow demand and scanty financial resources the arguments against keeping up plant are too imperative to be ignored.

Conditions of essentially the same kind but quite different in detail prevail in the field of municipal water-supply service. Here also the postponement of extension, modernization, even adequate maintenance, during the past five years has been very extensive. Only because of a sharp dip in water consumption did the average citizen remain unconscious of the results.

For a year or more the demand for water has again been on the increase. A study of this significant change, made for *Enginering News-Record* by the well-known authority Nicholas S. Hill and published elsewhere in this issue, indicates clearly that consumption on the whole is back to its pre-depression level and is rapidly moving upward toward the old trend line. All the evidence suggests that within another two or three years the temporary sag in the consumption curve will have been smoothed out completely. When that time arrives, the full weight of accumulated neglect and failure to provide for the future will make itself felt, and water service will be in much the same position as the machine-building industry in having to act quickly to make up for its accumulated obsolescence in order to protect the safety, economy and adequacy of the service against every mischance.

In respect to water-service the long-time outlook on future conditions has an importance far beyond that which applies to manufacturing or other industrial activities. No community can feel itself secure unless its plans for water are based on the foresight of estimating at least twenty-five years ahead. It is this that makes the slowing up of water-service development a matter of broad public concern, and rates Mr. Hill's study as a fundamental contribution to the day's thinking. The facts and conclusions address themselves in first instance to water-supply men, but their meaning to the citizen at large is at least equally great.

Progress and a Program

SOME fifteen years ago the American Water Works Association set up a policy-making council, which undertook an intensive study of the organization's problems. As a result of this work numerous sections of the association sprang up, a journal was started to supplant the annual proceedings, and a manual of waterworks practice came into being, the latter under the impulse of the late George W. Fuller's energy and driving force.

With the growth of activities there came also growth in membership. Its regional representation expanded to virtually complete coverage of the country. Related impulse gave rise to waterworks operators' schools and conferences, many of them independent of the AWWA but all clearly representing part of the same broad movement for the advancement of water service.

These are large achievements. But they also define a present obligation to prepare for further achievement. The mission of developing community water service in response to growing human needs is one that relies on sustained progress based on a farsighted program.

It may be that such a program will center in large part on administrative and social considerations, rather than on problems of engineering alone. Like gas and electric supply, water supply is an essential and permanent community service, differing from the others in that it is four-fifths municipally owned but having quite the same problems and the same relation to public welfare and comfort. Must not the association seek contact with these municipal-service groups, and with other agencies engaged in studying problems of municipal administration?

The fruitfulness of the association's activities and influence in future depends more largely on clear recognition of purpose and adaptation of function thereto than on detailed procedure in respect to technical discussion. Further, in order that the association may continue to bring together in one forum the broadest interests of the field, it will have to give thought to the relations between sections and central body, and the desirability of drawing the operators, schools and conferences into closer contact with it, so that unity may strengthen its accomplishment. Unquestionably also research will claim closer study. Whatever means are available for activating and supporting research deserve to be sought out and put to effective use.

In view of the dynamic, growing character of water service that is emphasized in this issue, the future path of progress of the AWWA presents a challenging field for study. With a forward-looking spirit, its leaders have a noteworthy opportunity to direct its policies to fit the changing needs of growth.

CURRENT NEWS

Large Projects Not Favored For Relief Work

(Washington Correspondence)

DENNISON DAM on the Red River in Texas has been identified as the $36,000,000 project referred to by President Roosevelt in his nation-wide broadcast of April 28 in explaining that the work-relief program will not include any new projects that cannot be completed within one year. The $36,000,000 project, the President said, would take three years to complete. Only $12,000,000 could be spent the first year, thus tying up $24,000,000 needed to provide immediate employment elsewhere. Furthermore, he said, the undertaking of such a large project in that area is not justified because $12,000,000 is more money than is required to absorb all employable men now on relief rolls.

Strict application of what President Roosevelt described as the "canons" of the work-relief program would eliminate from consideration much heavy engineering construction, such as the Corps of Engineers and the Bureau of Reclamation have charge of. Low-cost slum clearance housing plans, proverbially slow in execution, also would be shut out by the one-year requirement.

Obviously disconcerted by the President's statement, Administrator Ickes has suggested that it might be interpreted as not excluding projects which could be started this year with work-relief funds and carried on after termination of the present program out of new appropriations by Congress. This was the policy followed by PWA in making the initial allotments in 1933 for Grand Coulee, Bonneville, Fort Peck, Casper-Alcova and other large projects that will be carried forward with the new work-relief program.

Scioto Flood Project Reported as Uneconomic

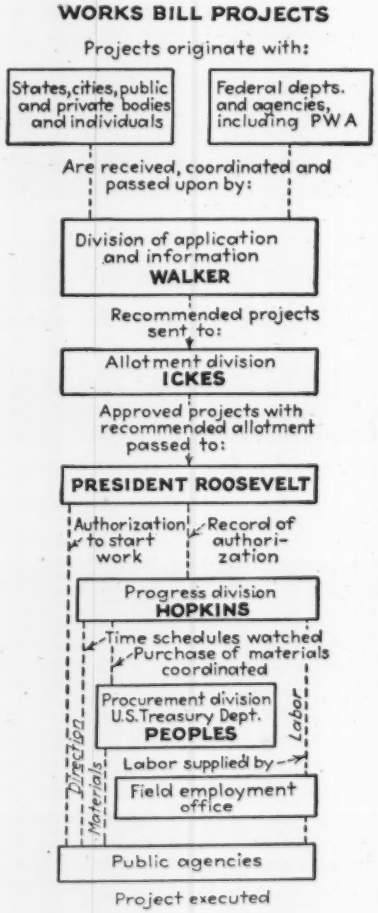
The proposed flood control project for the Scioto and Sandusky rivers in Ohio was declared to be economically unwarranted by army engineers in their report to the Board of Engineers for Rivers and Harbors.

The plan called for a ten-mile canal near Marion through which flood waters from the Scioto River would be diverted into the Sandusky, also for the construction of reservoirs to furnish hydro-electric power. Cost of the project has been estimated at figures from $18,000,000 to $30,000,000, depending on the alternative proposals for dams and reservoirs.

Although supporters of the project hope that allotments will be made, thus giving employment to about 6,000 men for three or four years, the report fixed the benefits at $130,200 a year, which, in the opinion of the engineers, cannot be justified.

Draftsmen Ruled Exempt From Code Hours Clause

The Construction Code Authority has ruled on the application of the code to architectural and engineering draftsmen. The Code Authority had been asked by an architect if the draftsmen under his employ, while working on plans for a large building, were governed by the maximum hours provision. In Explanation No. 34, approved April 10, the authority states that draftsmen while engaged in their accustomed duties under the employ of members rendering professional service shall be considered as engaged in professional work and shall therefore be exempt by the provisions of Art. III, Sec. 2B, 3(a) from the maximum hours as prescribed in the code. The code stipulated that with the exception of those employed in professional, executive or supervisory work no employee shall work more than 40 hours a week.



PROJECTS FOR FINANCING under the works relief bill will be handled in the manner indicated above, according to present indications, but whether the plan applies equally to federal and non-federal projects is not yet clear.

Works Projects Now Wait on New Organization

(Washington Correspondence)

WITH the overhead organization now practically complete, the work-relief program is waiting upon development of administrative procedure to start projects on their way to execution. Already flooded with plans for spending the $4,000,000,000 appropriation, the Division of Applications and Information, headed by Frank Walker, has still to recruit a staff of experts to classify and forward them to the Works Allotment Division, of which Secretary Ickes is chairman.

The key position in the new program is occupied by Harry Hopkins, head of the Progress Division. He is charged with keeping government agencies on the time schedule set for each project that is recommended by the Ickes board and approved by the President.

Non-federal projects

PWA lists were opened this week for receiving applications for non-federal projects. About 150 legal, financial and engineering examiners have been assigned by PWA to aid its state engineers in processing applications. Each application must have the recommendation of the field office when forwarded to Washington. It is not known definitely whether all applications, including those now in PWA files in Washington, will be routed through the Division of Applications and Information for consideration of the time element and the number of persons that will be employed.

Fundamental requirements

The President has established six fundamental principles to determine the eligibility of a project and its selection with respect to location:

1. The projects should be useful.
2. Projects shall be of such nature that a considerable proportion of the money spent will go into wages for labor.
3. Projects which promise ultimate return to the Federal Treasury of a considerable proportion of the costs will be sought.
4. Funds allotted for each project should be actually and promptly spent and not held over until later years.
5. In all cases projects must be of a character to give employment to those on the relief rolls.
6. Projects will be allocated to localities or relief areas in relation to the number of workers on relief rolls in those areas.

Federal agencies charged with responsibility for carrying on the work program will be called upon to explain any lag in execution. On non-federal projects, publicity will be used to keep states, cities and other political subdivisions on their toes. Cancelling of allotments will be the penalty for chronic procrastination. In every employment district, there will be a field official of the Progress Division to keep work in motion.

After studying the probable scope of the work program in relation to the federal

departments and agencies qualified to undertake it, the President found it necessary to create only three new units. A division in the Bureau of Public Roads will take charge of grade crossing elimination projects. Rural electrification will be placed in the hands of a unit independent of the quasi-judicial Federal Power Commission, or any other branch of the government. Morris L. Cooke, of the National Resources Board, is named as the probable head of this feature of the work relief program. As director of rural resettlement activities, Rexford G. Tugwell will take over subsistence homestead projects and the FERA rural communities.

Purchase of materials

Purchase of materials will be centralized by a procurement office, headed by Rear Admiral Christian J. Peoples in the Progress Division. All orders will be lumped, with the expectation of obtaining reduced prices on the basis of volume. Cement was mentioned by President Roosevelt in his national broadcast as an example. How far this centralized purchasing will be carried is not yet clear.

Labor

Labor will be supplied from relief rolls in the same district where the project is located by field employment offices under the jurisdiction of Mr. Hopkins. The amount of "security payments" to be paid to labor as determined by Mr. Hopkins will vary from district to district but there is no indication that he or the President will concede to organized labor the payment of prevailing rates on any work except federal buildings, on which the law requires that the prevailing rate shall be predetermined and written into the contract.

Works allotments

All allotments from the $4,000,000,000 work-relief appropriation will be made by President Roosevelt, on the recommendation of the Works Allotment Division, of which Harold L. Ickes is chairman. The President may make changes in the list of recommended projects, but he says that the vast majority, having been carefully studied, will be approved. The WAD, as constituted at present, includes in its membership the following:

Harold L. Ickes, chairman, Secretary of the Interior; Henry A. Wallace, Secretary of Agriculture; Frances Perkins, Secretary of Labor; Frank C. Walker, director, National Emergency Council; Harry L. Hopkins, director, Progress Division; Rear Admiral C. J. Peoples, director, Procurement Division (U. S. Treasury); Daniel W. Bell, director, Bureau of the Budget; Frederic A. Delano, vice chairman, National Resources Board; Maj. Gen. Edward M. Markham, Chief of Engineers; Elwood Mead, Commissioner of Reclamation; Hugh H. Bennett, director of Soil Erosion; F. A. Silcox, chief of the Forest Service; Robert Fechner, director of Emergency Conservation Work; Thomas H. MacDonald, chief of the Bureau of Public Roads; Rexford G. Tugwell, director of Rural Resettlement.

Yet to be appointed are: director of rural electrification; chief of the Division of Grade Crossing Elimination; director of Relief; chief of the Urban Housing Division, and a representative each from the Business Advisory Council, organized labor, farm organization, the American Bankers Association, and the U. S. Conference of Mayors.

PWA Engineers Ordered To Receive Applications

To speed up projects under the new work relief program Secretary Ickes has telegraphed to PWA state engineers authorizing them to accept new applications for loans and grants for non-federal projects. Applications are to be received on the same basis as before but with terms and conditions subject to revision when new regulations are announced.

Since February, 1934, PWA has not received any applications because at that time it had more than could be financed under the original appropriation.

PRINCIPAL FEDERAL AGENCIES PARTICIPATING IN WORKS BILL

(Based on the White House statement of April 24)

Major Operations

Bureau of Public Roads (Agric.)—Highway projects; grade crossing eliminations.
PWA (Federal Emergency Administration of Public Works)—Loans to states, municipalities, or subdivisions to construct projects.
Forest Service (Agric.)—Projects relating to the development of national forests.
Engineer Corps (War)—Rivers and harbors, flood control, etc.
Bureau of Reclamation (Interior)—Reclamation Projects.
National Park Service (Interior)—Roads, fire lanes, and other national park projects.
Soil Erosion Service (Agric.)—Soil conservation programs.
Bureau of Indian Affairs (Interior)—Projects on Indian reservations.
Bureau of Yards and Docks (Navy)—Buildings and other improvements, yards and docks, in naval reservations.
Quartermaster General (War)—Buildings and other improvements in military reservations.
Tennessee Valley Authority—Projects relating to its program.
Geological Survey (Interior)—Topographic maps.
Procurement Division (Treasury)—Construction of federal buildings. Supervision of all purchasing for entire program.

Auxiliary Agencies Handling Major Expenditure

FERA—Relief problems (so listed in release of April 24, but probably also carrying on much work relief at least during part of the time).
CCC—Conduct of enlarged range of emergency conservation work.

Agencies of Minor Activity

Coast Guard (Treasury)—Coast guard stations, cutters.
Justice Dept.—Projects relating to federal prisons.
Office of Experiment Stations (Agric.)—Work on buildings and grounds of agricultural experiment stations.
Veterans Administration—Veterans hospitals, etc.
Bureau of Plant Industry (Agric.)—Buildings and grounds and experimental work.
Bureau of Dairy Industry (Agric.)—Buildings and grounds of laboratories.
Bureau of Lighthouses (Commerce)—Lighthouse establishments.
Bureau of Air Commerce (Commerce)—Airports.

Research

Research and other white collar projects may be developed in various departments, such as Bureau of Animal Industry (Agric.), projects relating to the prevention of animal diseases; Biological Survey (Agric.), wild life reservations, and predatory animal and rodent control; Bureau of Entomology and Plant Quarantine (Agric.), control of insects and plant diseases; Bureau of the Census (Commerce), census and statistical work; Bureau of Foreign and Domestic Commerce (Commerce), business surveys; Bureau of Fisheries (Commerce), projects relating to development of fish culture; Federal Power Commission, research relating to power; Bureau of Labor Statistics (Labor), statistical work on labor, employment and prices.

Additional workers may be required by a number of other government bureaus to handle the increased work resulting from the works program.

Construction of Parker Dam Found to Be Unauthorized

The U. S. Supreme Court, in a decision handed down on April 29, declared that construction of Parker Dam on the Colorado River has not been authorized by Congress as required by law, and that, therefore, there is no ground for granting an injunction against the state of Arizona to keep it from interfering with construction of the dam, as asked by the federal government.

Parker Dam, located about 150 miles below Boulder Dam, is an essential part of the aqueduct system by which the Metropolitan District of Southern California expects to deliver Colorado River water to cities in the Los Angeles district. When its construction was proposed by the district, the state of Arizona threatened to use force to prevent work on the Arizona side of the river. Subsequently, the Bureau of Reclamation undertook to construct the dam for the district and let a contract for its construction, but because of the continued objection by Arizona the bureau has confined all operations to the California side.

On Jan. 14, 1935, the United States filed a bill in the Supreme Court to enjoin interference by Arizona. This bill the court has dismissed.

In a long decision the court reviewed the history of the project and its relation to the Boulder Canyon project, pointing out that the dam was not authorized by the Boulder Canyon Act. It pointed out further that by long-accepted practice no dam on a navigable river can be built without specific authorization by Congress, and that that authorization is granted only after the project has been studied by the Corps of Engineers and favorably reported on to Congress by the Secretary of War. This, the court said, had not been done.

The court also held that construction was not authorized as required by the Reclamation Act, and that the government's contention that it is being built under authority of the Recovery Act is without force.

Large Imhoff Tank Group Completed at Chicago

The largest group of Imhoff tanks ever installed has been put into operation at Chicago's West Side sewage treatment plant at Stickney, Ill. The third battery, just completed, increases the capacity of the plant for partial treatment to 472 m.g.d. The three batteries of 108 tanks serve an area of 100 sq.mi. Pending the completion of 21 miles of intercepting sewer tunnels now under construction the plant will not be in full operation. Work on the third battery of 36 tanks, costing $2,700,000, was started by the Sanitary District in 1930 but was abandoned in 1931 because of lack of funds. In 1934 a PWA loan and grant allowed the work to be resumed. S. A. Healy, Detroit, is the contractor.

Work on the Chicago Southwest activated sludge treatment plant has already gotten under way with the award of a contract for aeration and settling tanks to the Herlihy Mid-Continent Co. of Chicago.

Engineers believe that the plant can be built at a cost of only $28,000 per million gallons daily as evidenced by the first bids received for construction work. Contract for the first section of intercepting sewer tunnels to serve this plant has just been let to S. A. Healy.

Lehman Signs Law For New York Job Insurance

NEW YORK'S unemployment insurance law has been signed by Governor Lehman and according to its terms will go into effect immediately.

The unemployment insurance law embraces all those concerns which employ at least four persons within each of thirteen or more calendar weeks in 1935 or any subsequent year. It provides that employers shall contribute an amount equal to one per cent of the employees payroll for the year 1936, two per cent for 1937, and three per cent for every year thereafter. None of the funds are to be contributed by employees. For the purpose of this law the term "employee" means any person, including aliens and minors employed for hire by any employer subject to the law, except any person employed at other than manual labor at a salary of more than $2,500 a year or more than $50 a week. Contractors entering into agreement with subcontractors will be liable for the contributions measured by the wages of the persons employed by the subcontractor, except in cases where the subcontractor accepts full liability for the contributions.

Benefits will be paid in the ratio of one week of benefit for each fifteen days employment. But no employee shall receive benefits unless he has been unemployed for ten weeks. Nor shall he be entitled to the benefits if he loses his job because of misconduct or because of a strike.

If the occupation is only seasonal and it is not customary to work more than eighteen weeks in the year, and if there are persons employed in that work who are not ordinarily employed during the rest of the year the commissioner shall determine the right to benefits of the employee. But no industry shall be considered seasonal until the commissioner has made such a determination.

E. W. Sheets, Beltsville Supervisor, Dismissed

Investigation of the construction of the Department of Agriculture research center at Beltsville, Md., has culminated in dismissal from the federal service of Earl W. Sheets, former chief of the animal husbandry division of the Bureau of Animal Industry. Charged with "neglect of duty, maladministration and misfeasance," Dr. Sheets' dismissal becomes effective May 15.

The investigation revealed "no actual dishonesty" as a cause of a shortage in accounts which developed out of an attempt to spread PWA allotments totaling $2,481,017 over more projects than were authorized (*ENR*, Oct. 25, 1934). In the hope of accomplishing this, day labor was employed on force account and it was also charged that PWA wage and hour requirements were ignored.

Last October the Department of Agriculture was instructed by PWA to cover the "deficit" on the Beltsville operation by transferring the funds necessary for bringing it to completion from allotments made to the department for other purposes.

Clement Named President Of Pennsylvania R. R.

Martin W. Clement has been named to succeed W. W. Atterbury as president of the Pennsylvania Railroad. Mr. Clement has been acting head of the system since Mr. Atterbury's illness last July.

The new president was born in Sunbury, Pa., 1881, and received his B.S. degree from Trinity College, Hartford, Conn., in 1901. The same year he entered railroad service as a rodman in the maintenance of way department of the Pennsylvania Railroad. In 1905 he became assistant supervisor and continued in the engineering department until 1916. In 1926 he became vice-president in charge of operations. In 1931 Mr. Clement became vice-president, in which capacity he aided Mr. Atterbury.

Mr. Clement holds directorships in such companies as the Main Line Trust Co., the Railway Express Agency, the Western Union Telegraph Co., and the Insurance Company of North America. He was also instrumental in forming the Association of American Railroads about a year ago.

Court Refuses PWA Funds To Buzzard's Roost

An injunction granted to the Duke Power Co. by Judge H. H. Watkins of the federal district court at Greenville, S. C., on April 23 against Greenwood County, S. C., and against Secretary Ickes as PWA administrator prohibits the use of PWA funds to set up a power plant in the Buzzard's Roost electrical project on the Saluda River.

The court did not challenge the right of the government to build utilities or to regulate rates, but held that the project in effect would be proprietary and not a public enterprise since the power would be sold to private interests. It was also ruled that the effect of the project would be to impair and destroy the business of the Duke Power Co. Judge Watkins also held that Congress could not legislate for local enterprise under the general welfare clause of the Constitution and that the Buzzard's Roost project would not be involved in interstate commerce.

J. I. Ballard Made Editor of Western Construction News

James I. Ballard, formerly assistant editor of *Engineering News-Record*, New York, has been appointed editor of *Western Construction News*, with headquarters at San Francisco. Mr. Ballard is a graduate of North Dakota State College and took post-graduate work at the University of California. Subsequently he was with the East Bay Water Co. and with W. L. Huber, consulting engineer. He joined the editorial staff of *Engineering News-Record* in January 1929 as an editorial assistant in the San Francisco office, subsequently becoming Pacific Coast editor. He was transferred to the New York office in 1934.

Large Sewerage System Planned for Detroit

A $25,000,000 sewer project for Detroit and environs, sponsored by the Metropolitan Sewerage and Water Commission, has been submitted to PWA authorities in Washington by the Michigan Planning Commission as the most important project for the Detroit area.

In furtherance of the project, it was pointed out recently by the Michigan Stream Control Commission that continuation of the present practice of discharging untreated sewage into the Detroit River will be in contravention of the treaty of 1909 between the United States and Canada, will violate public and private riparian rights and will violate state laws.

The plans under consideration contemplate utilizing a system of intercepting sewers to carry the bulk of the sewage to a plant in the southeast section of Detroit. This plant would serve Detroit and also care for the flow from Wayne County above Detroit, eliminating any open sewage flow into Lake St. Clair and the Detroit River. Down-river areas would be served by other treatment plants.

The comprehensive sewerage system which has been devised would serve 44 cities and villages. Based upon a population of 1,900,000, the estimated annual cost of operation is 87c. per capita.

Ickes Sponsors Bill to Change Scope of Interior Department

CENTRALIZATION of the conservation activities of the government is the objective of a bill introduced in the Senate April 24 by Senator James Hamilton Lewis, majority whip, at the request of Secretary of the Interior Ickes. The measure has the President's endorsement and would empower him to organize within a period of two years the present Interior Department as a Department of Conservation and Works. This would be accomplished by the transfer of government bureaus into or out of the department by executive order, subject to review by Congress within a period of 60 days, or within a like period of time after the convening of a session.

Secretary Ickes stated that introduction of the bill does not signify that a plan for reorganization of the department has already been developed. Such legislation, he said, would merely give to President Roosevelt the opportunity to do what he thinks is best in the interest of better administration and economy. As for changing the name of the department, Secretary Ickes remarked that the present title is meaningless, since conservation has become a major interest of the government.

Secretary Ickes expressed himself emphatically in favor of a permanent public works program, pointing out that he had subscribed to the report of the National Resources Board which recommended an annual expenditure of $500,000,000. Introduction of the legislation revealing Secretary Ickes' hopes for reorganization of his department follows his previous proposal for the appointment of an undersecretary to share the responsibilities of his office.

Aerial Mapping Body Holds First Annual Meeting

The first annual meeting of the American Society of Photogrammetry was held in Washington, April 22 and 23, 1935. The program included exhibits presented by each of the federal agencies engaged in the use of aerial photographs in mapping and by several commercial aerial photographic companies that have been supplying photographs and mosaics under government contracts.

Twenty-one papers were presented. They covered such subjects as specifications for aerial photographs, airplane photography from the commercial viewpoint, consulting engineering services in connection with aerial surveys, photographic lenses, mapping and plotting methods, and high-altitude mapping. Several papers described specific mapping operations such as that in the Tennessee Valley.

The American Society of Photogrammetry was organized in August, 1934, and was incorporated for scientific and educational purposes under the laws of the District of Columbia. Membership includes any person who is "actively engaged in the practice of photographic mapping, or who, by reason of education or profession, is interested in the application or development of photogrammetry." At the time of the annual meeting the membership was 200.

At the International Congress of Photogrammetry, held at Paris in November, 1934, the American Society was admitted to membership in the International Society of Photogrammetry.

The following officers were elected for the year 1935: president, C. H. Birdseye, U. S. Geological Survey; vice presidents, J. W. Bagley, Corps of Engineers, and O. S. Reading, U. S. Coast & Geodetic Survey; secretary, J. W. Ninneman, and treasurer, M. S. Wright, both of the U. S. Forest Service.

Fifteen directors were elected to cover the United States geographically and to include representatives of commercial concerns, universities and scientific organizations.

Subsidy Offered Builders Of 1,200 Modern Homes

A housing program designed to produce one new house for each 100,000 of population throughout the country by Sept. 1, 1935, has been launched by the General Electric Co. as a follow-up to its recent architectural competition in which more than 9,000 architects submitted some 2,000 sets of drawings. The general plan is to offer selected builders one of the 52 prize-winning designs, substantial discounts and terms on electrical equipment, and, national advertising and support, all in consideration of the construction by these builders of demonstration houses. J. F. Quinlan, who was in charge of the architectural competition, will head up the new organization for the building program, with headquarters in New York. The company's distributors and district officers will handle the details in the local communities. It is planned to start construction as soon after May 15 as possible.

A selection of the prize-winning plans will be made available to the builders.

Housing Program of PWA Enlarged And Advanced

SEVERAL developments in recent weeks have served to advance and enlarge the low cost housing program of the Public Works Administration. Among them is the start of condemnation proceedings for a $6,000,000 project in Detroit, similar action on New York's $12,500,000 Williamsburg project, allotment of $2,800,000 for a project on Cleveland's West Side, signing of a contract for constructing the University housing project in Atlanta and opening of bids May 1 for the $3,000,000 Cedar-Central project in Cleveland.

Options on 52 per cent of the 378 parcels of property included in the 51-acre Detroit site had been obtained before it was decided to resort to condemnation. Selected for immediate development is a 34-acre tract on which apartment buildings and row houses will provide 3,569 rooms for negro occupancy. The site is within ten minutes walking distance of Detroit's business section.

In New York final condemnation proceedings to secure title to twelve square blocks in the Williamsburg section of Brooklyn were instituted, to expedite acquisition of the land. This project is novel in that the land, once obtained, will be leased to the New York Municipal Housing Authority which will construct the new housing.

Formal announcement of a third slum clearance and low-rent housing project in Cleveland was made last week. It involves a 22-acre site on a hillside overlooking Lake Erie adjacent to Edgewater Park on the west side of Cleveland. The architects selected for the project, Joseph L. Weinberg and the firm of Conrad & Tearl, originally presented it to the PWA Housing Division as a limited dividend project. Plans call for the construction of 621 modern family units in two-story row houses and in two- and three-story apartment buildings.

Awarding of a contract to the N. P. Severin Co. for $1,985,000 for the University housing project in Atlanta gave that city the distinction of having the first two construction jobs in the all-federal housing program located there, the Techwood development being actively under way. In addition to these two projects, which have reached the construction stage, building demolition work is under way in Indianapolis, Cleveland, and Montgomery, Ala. Demolition bids are being considered for the Outhwaite project in Cleveland and the Williamsburg development in New York.

Committee Picked to Study Central Valley Project

PWA Administrator Ickes has appointed a special committee of three men to study California's Central Valley project and to make recommendations for any changes found necessary in the state's basic Central Valley Act.

The committee is to be headed by Elwood Mead, Commissioner of Reclamation, and to have as its other members Carl Farbach of the PWA legal staff and David C. Coyle of the engineering staff of the National Resources Board.

The Central Valley project is a plan to conserve water resources in the San Joaquin and Sacramento valleys for irrigation and for opening the rivers to navigation (*ENR*, July 19, 1934, page 85).

SITE OF CLEVELAND'S third slum elimination project. Located on the west side of the city overlooking the Cuyahoga River and Lake Erie, the 22 acre site will accommodate a $2,800,000 project. On Cleveland's other two projects construction bids are being considered on the Cedar-Central project between East 21st and East 35th Sts., and building demolition bids are being considered on the Outhwaite project between East 40th and East 54th Sts.

Washington Highlights

By Paul Wooton

Intensive study of new sources of taxes is seen as additional evidence that there will be revenue legislation at this session of Congress.

A broad movement in refunding operations is going on throughout the country. Interest rates have fallen sharply and it has become profitable to refund many outstanding bond issues.

Despite active opposition, indications are that the Administration's banking bill will find its way to the statute books. Among other things it liberalizes loans that may be made on real estate.

There are some who think the NRA is the Administration's worst blunder. While they do not expect acknowledgment of failure before the election, particularly when 7,000 jobs are involved, they predict that the organization will have been pushed out of the picture before the end of the extension Congress is expected to grant.

Preparations are being made to do a thorough-going job on erosion control. Work thus far has been confined to forty demonstration projects in thirty-six states. Under the new plan the work will be extended to private lands wherever the necessary local cooperation can be secured.

Prospects are against legislation broadening the licensing power of the Agricultural Adjustment Administration.

Four billion dollars is five per cent of the national income in a good year. Officials say the works relief appropriation is not enough to prime so big a pump, but the active cooperation of private industry can furnish enough jobs.

National Society Sets Up Washington Headquarters

The National Society of Professional Engineers established its permanent headquarters in the National Press Building in Washington on May 1.

The headquarters office will be in charge of Willard S. Conlon, treasurer of the society and acting secretary. T. Keith Legaré, who in addition to his duties as secretary of the National Council of State Boards of Engineering Examiners has been functioning as executive secretary of the society since September, 1934, resigned on April 15. Mr. Conlon until recently was city engineer and manager of the department of public works of Stamford, Conn.

N. J. Creates One-Man Highway Commission

The New Jersey senate bill creating a one-man highway commission and abolishing the old commission of four men has been passed by the assembly and signed by Gov. Hoffman who sent the name of E. Donald Sterner to the senate for approval as highway commissioner. Mr. Sterner has been the governor's secretary and according to the new law will serve as commissioner for six years.

SOCIETY CALENDAR

AMERICAN WATER WORKS ASSOCIATION, annual convention Cincinnati, Ohio, May 6-10.

AMERICAN INSTITUTE OF ARCHITECTS, annual convention, Milwaukee, Wis., May 28-30. THE PRODUCERS' COUNCIL will hold its 12th annual meeting in connection with the Institute meeting.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

News Briefs

A PROPOSAL FOR A MUNICIPAL electric plant in Auburn, N. Y., to be constructed at a cost of $1,500,000 was defeated in a city-wide referendum.

A PLAN TO DREDGE THE SUSQUEHANNA RIVER from Port Deposit to its mouth has been rejected by the rivers and harbors committee of the House of Representatives on the ground that benefits to be derived from a deeper channel would not justify the expenditure.

GOV. GUY B. PARK of Missouri has signed a bill providing for the creation of boards of trustees to supervise the construction or acquisition of toll bridges and the operation and maintenance of such structures. Under the terms of the bill, from three to seven freeholders, electors of the state, may become a corporate body as state highway toll bridge trustees and be deemed a public agency within the meaning of the law. The trustees may issue toll bridge revenue bonds to be liquidated through tolls collected for crossing the bridge.

GOVERNOR GREEN OF RHODE ISLAND has vetoed a bill providing for a popular referendum on the purchase of the Mount Hope bridge to include it in the state highway system. The governor stated that the voters would have no knowledge of the price to be paid for the bridge, which was built a few years ago at a cost of about $3,897,000. The structure, owned by the Mount Hope Bridge Corp., is a toll bridge and has lately been in the hands of a receiver.

THE DEEPENING OF BUTTERMILK CHANNEL between Governor's Island and Brooklyn, N. Y., has been completed by army engineers. The channel is now 40 ft. deep and 500 ft. wide and connects the East river with channels in the upper bay. Dredging operations were started in 1933, when it was decided that the former depth of 30 ft. was not sufficient for the increasing traffic. A proposal now has been put forward to increase the channel width to 1,200 ft. to allow room for docking.

THE NATIONAL RAILWAYS OF MEXICO, under an agreement made with the ministry of communications and public works which modifies a contract drawn up on March 2, 1912, will proceed with the construction of a railroad to connect the states of Vera Cruz, Puebla and Tamaulipas. This work must be started within two years from the date of the agreement, April 16, and the company is obligated to complete 100 km. of the line within the next two years. The agreement allows the railways to import duty free all materials, machinery, apparatus, equipment, etc., required for this work.

Personals

S. F. Crecelius, project engineer on Unit No. 1 of the Nogales, Ariz., flood control project, has been transferred to Las Cruces, N. M., in charge of surveys of the Rio Grande from the proposed site of the Caballo dam to El Paso, Texas.

BEN H. HUSSEY, for a number of years associated with the Vicksburg, Miss., district office of the U. S. Engineer Corps, has been named area engineer for the Pine Bluff, Ark., area and will have headquarters at Lake Providence. Mr. Hussey succeeds Harry Doyel, transferred.

S. H. OSBORNE, division engineer for the Union Pacific R. R. at Denver, Col., has been advanced to the office of assistant to the vice president in charge of safety, with headquarters in Omaha. CHARLES W. PITTS, who was Mr. Osborne's assistant, has been named division engineer.

LIEUT. COL. EUGENE REYBOLD, transferred to Memphis as district engineer, was born at Delaware City, Md., in 1884. He graduated in engineering at Delaware College in 1903. In 1926 he was transferred to the engineer corps and from 1927 to 1932 was district engineer at Buffalo, N. Y. In 1933, he was made district engineer at Wilmington, N. C., where he has since been located.

JAMES L. ROGERS has been appointed as the head of a new division of planning by directors of the Muskingum watershed conservancy district. Mr. Rogers formerly was with the rural rehabilitation department of the Ohio relief commission. The new division will cooperate with residents of small towns affected by the project and help them work out problems of relocation.

WILLIAM L. DARLING was guest of honor at a dinner given by the Northwestern Section of the American Society of Civil Engineers on April 18 in St. Paul, Minn. The dinner was held to celebrate Mr. Darling's election to honorary membership in the American Society of Civil Engineers. Mr. Darling has long been active in the construction and operation of railroads and is a member of the St. Paul city planning board.

CLIFFORD OLDER, for many years chief engineer of the Illinois state highway department, and more recently a member of the firm of Consoer, Older, and Quinlan, has severed his connection with that firm. As bridge engineer in the Illinois highway department, Mr. Older gave special attention to raising the standards of bridge design and construction. By combining research, theory and practice, he also did much to put paved road design on a sound technical basis.

SAMUEL B. MORRIS, chief engineer and general manager, Pasadena Water Department, has been appointed executive head, Department of Civil Engineering, Leland Stanford Jr. University, succeeding Prof. J. C. L. Fish, who will retire emeritus at the end of the current academic year. Mr. Morris, who is 44, graduated from Stanford in 1911 and for 23 years has been with the Pasadena Water Department. Recently he designed and built the concrete storage dam in San Gabriel Canyon, officially christened "Morris Dam" in his honor.

Obituary

WILLIAM T. REED, for many years a prominent building contractor at Lynn, Mass., died in Lynn on April 28 at the age of 62.

W. F. LODGE, past president of the Illinois Contractors Association, died at his home in Monticello, April 18.

JOHN C. MOORE, 53, district office engineer of the state division of highways in Los Angeles, died April 17. He was a native of Grand Rapids and was educated at the University of Michigan.

A. B. BOBBS, contracting structural engineer, died in Chicago, April 13. For a number of years he was chief engineer for the bureau of architecture of San Francisco, Calif.

CHARLES N. PERRY, Los Angeles, Calif., consulting engineer since 1922, died April 20. He was 69 years of age. Mr. Perry was one of the engineers who laid out some of the major canals and waterways of the Imperial Valley irrigation system and was engaged as an irrigation expert for one of the large valley ranches near Calexico, Calif.

JOHN E. LOWTHER, consulting civil engineer, died March 14 at Winneconne, Wis., following a year's illness. His early experience was with the Chicago, Milwaukee & St. Paul R. R., where he rose to be assistant engineer. At one time he was city engineer of Wauwatosa, Wis.

WILLIAM A. SMITH, 54, village engineer of Bronxville and Tuckahoe, N. Y., died April 16 at Lawrence Hospital, Bronxville, after an operation. Mr. Smith was vice president and director of the Westchester Society of Civil Engineers and member of the American Society of Civil Engineers.

ERNEST WILDER CLARKE, 67, died at his home in Pleasantville, N. Y., April 24. Mr. Clarke had been in the engineering division of the department of sanitation of New York from 1931 until his retirement on April 1. He was born in Syracuse, N. Y., in 1868. From 1904 to 1906 Mr. Clarke was an engineer with the sanitation section on the building of the Panama Canal and later was on the Catskill Aqueduct.

J. C. MURPHY, 71, former chairman of the Louisville, Ky., planning and zoning commission, died at his home April 14 following an illness of fourteen months. He had resigned from the planning commission last September on account of ill health. Mr. Murphy had served as trustee of the University of Louisville since 1922.

JOHN ROTH, 66, retired construction engineer of Buffalo, N. Y., died April 14. Mr. Roth assisted in supervision of erection of the Pan-American exposition buildings in Buffalo and also the World's Fair in Chicago. Born in Wurtemburg, he received his engineering and architectural training at the University of Zurich, Switzerland. He was superintendent for many years of the Durolithic Corp.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards are lower this week due to lower private awards. At $18,341,000 they represent a drop of 11 per cent below last week and 21 per cent below the average week in May a year ago. Private awards at $3,627,000 are less than half last week's volume. State and municipal awards at $12,750,000 are higher than a week ago while federal at $1,964,000 are lower. Total public awards are $14,714,000.

Increases are recorded in waterworks at $1,433,000 for the week; in bridges at $1,266,000; in commercial buildings at $1,732,000 and in unclassified at $2,715,000, while other classifications of work dropped below last week. Industrial building awards were $1,749,000 for the week; public buildings, $2,962,000; streets and roads, $5,003,000; sewerage, $172,000; and earthwork, irrigation and waterways, $1,309,000.

State and municipal bond sales total $6,981,000 for the week. Their effectiveness in adding to the new capital for the year is diminished by net reduction in non-federal PWA allotments outstanding of $4,115,000 due to excess of reductions and rescissions over reallotments. Federal allotments for the week from PWA funds total $1,253,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average May 1934	Prev. 4 Weeks	Week May 2 1935
Federal Government	$3,144	$4,661	$1,964
State and municipal	14,597	13,972	12,750
Total public	$17,741	$18,633	$14,714
Total private	5,607	10,610	3,627
Week's total	$23,348	$29,243	$18,341
Cumulative to date: 1934...$511,359,000	1935...$442,624,000		

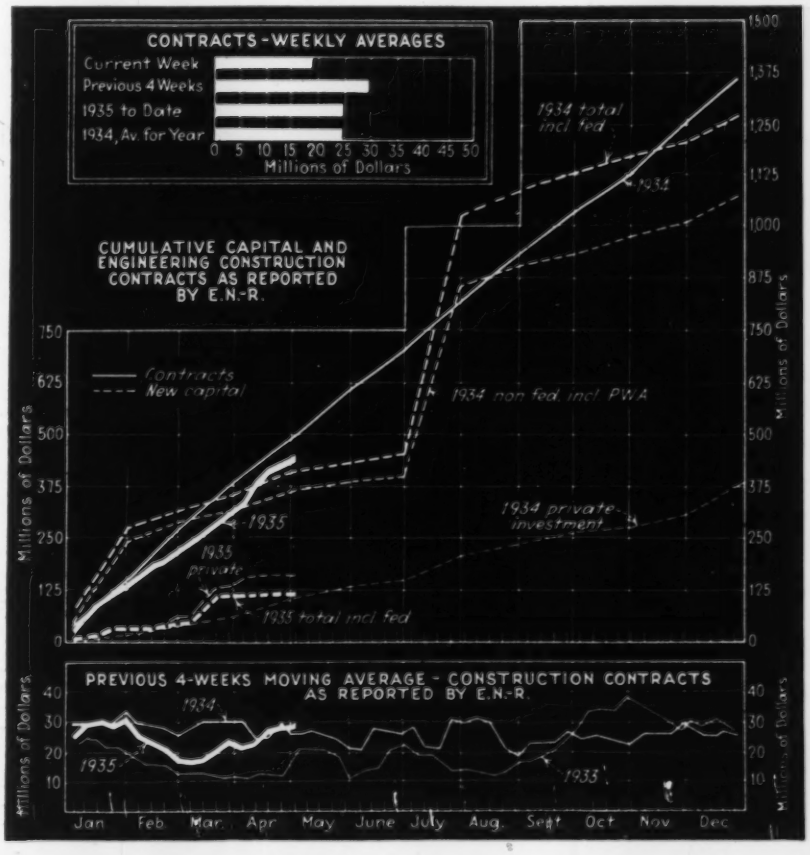
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1935	Week May 2	Cumulative
State and municipal	$6,981	$146,082
PWA allotments, S&M	—4,115	—42,541
RFC loans, S&M	.....	84
Corporate issues	.....	.....
PWA allotments, private	380	8,509
Total, Non-Federal	$3,246	$112,134
PWA allotments, Federal Constr.	1,253	8,589
Total new capital	$4,499	$120,723
Cumulative to date: 1934...$410,233,000	1935...$120,723,000	

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.

INDEX NUMBER

E.N.R.- Cost	1913 = 100	1926 = 100	E.N.R.- Volume	1913 = 100	1926 = 100
May, 1935	**194.06**	**93.28**	**Apr., 1935**	**130**	**57**
Apr., 1935	194.50	93.49	Mar., 1935	106	44
May, 1934	199.61	95.95	Apr., 1934	109	48
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1935 to Date
1934, Av. for Year
0 5 10 15 20 25 30 35 40 45 50
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Contracts
New capital
1934 total incl fed
1934
1934 non fed incl PWA
1935
1933 private
1934 private investment
1935 total incl fed
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

BUSINESS SIDE OF CONSTRUCTION

April Awards Higher Than Year Ago All Territories Gain But South

ENGINEERING construction awards for April total $116,972,000 compared with $101,192,000 a year ago, a gain of 15 per cent. This gain was due to the substantial increase in private construction from $17,737,000 last April to $42,439,000 this year. Public construction of $83,455,000 last April compares with $74,533,000 this year of which state and municipal work a year ago represented $59,111,000 compared with $55,137,000 this year and federal work made up $24,344,000 last April and $19,396,000 this year.

Total awards to date for the first four months of this year at $424,283,000 compare with $486,238,000 for the same period last year, a drop of 12½ per cent. For the same period private work totals $108,487,000 compared with $81,698,000, a gain of almost 33 per cent.

The E.N.-R. cost index has dropped back about 7.8 points below last year's high, due principally to the price adjustment of lumber after the first of the year and to a slight lowering in the labor wage average. It has steadied close to 194 and held this position for three consecutive months. The volume index benefits from this adjustment downward and climbs to 130 this month.

By classes of work the losses from the first four months of last year are in bridges, from $34,194,000 to $23,159,000; in earthwork, irrigation and waterways, from $121,174,000 to $61,411,000; and in highways, from $125,942,000 to $90,523,000 this year. Gains are recorded in waterworks, from $16,219,000 to $24,837,000; in sewerage, from $15,878,000 to $18,760,000; in private bridges, from $2,583,000 to $4,937,000; in industrial buildings, from $35,798,000 to $43,802,000 and in commercial buildings, from $23,233,000 to $29,937,000.

All territories gained except South but the heaviest gains were recorded in Middle Atlantic, Middle West and Far West.

New Capital

State and municipal bond sales totalled $28,735,000 for the month while PWA rescissions and reductions continued to withdraw more commitments to federal financing than were realloted by the Public Works Administration. At the end of the four months period PWA allotments outstanding for non-federal work were $38,426,000 less at the first of the year.

State and municipal bond sales total $139,101,000 for the first four months.

Materials

Cement—Cement shipments in March totaled 4,877,000 bbl. as reported by the U. S. Bureau of Mines. This represents an increase over February of 65 per cent and an increase over March 1934 of 5½ per cent. The ratio of production to capacity declined from 23.0 in March, 1934 to 18.9 in March, 1935. The March ratio

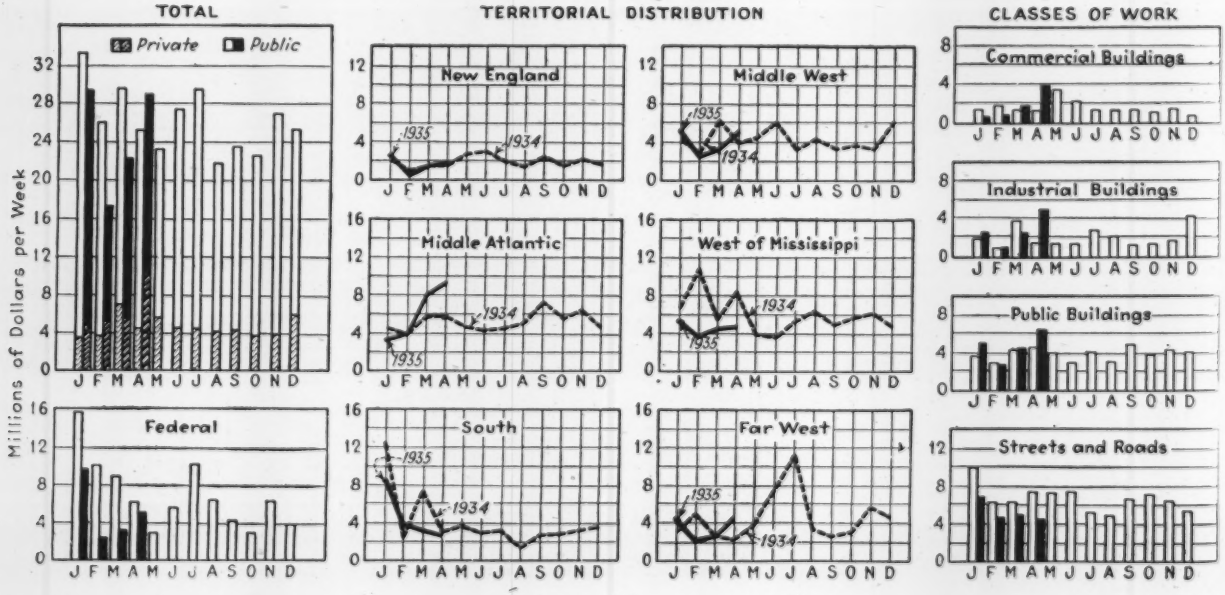
ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN APRIL, 1935

Four Weeks—Thousands of Dollars—(000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States April 1935	United States Four Months 1935	United States Four Months 1934	Canada
Public Works										
Waterworks	109	1,849	273	1,131	339	4,009	7,710	24,837	16,219	220
Sewerage	560	871	161	2,269	391	328	4,580	18,760	15,878	7
Bridges, public	150	474	371	708	402	393	2,498	23,159	34,194	.....
Earthworks and waterways	227	417	1,599	2,631	4,663	845	10,382	61,411	121,174	47
Streets and roads	1,635	3,375	3,694	2,880	3,332	3,549	18,465	90,523	125,942	89
Buildings, public	1,336	11,344	3,141	2,031	3,646	3,736	25,234	80,308	67,133	518
Unclassified, public	108	2,516	107	148	370	2,415	5,664	16,798	24,000	30
Total public	4,125	20,846	9,346	11,798	13,143	15,275	74,533	315,796	404,540	911
Federal gov't (included in above classifications)	304	3,479	4,169	4,089	5,320	2,035	19,396	90,590	172,252	.....
Private										
Bridges, private	.....	30	.....	.....	326	.....	356	4,937	2,583	.....
Buildings, industrial	345	2,472	252	6,532	3,066	6,212	19,379	43,802	35,798	274
Buildings, commercial	420	13,486	361	972	120	295	15,654	29,937	23,233	.....
Unclassified, private	2,623	232	405	1,259	2,525	6	7,050	29,811	20,084	.....
Total private	3,388	16,220	1,518	8,763	6,037	6,513	42,439	108,487	81,698	274
April, 1935 (4 weeks)	**7,513**	**37,066**	**10,864**	**20,561**	**19,180**	**21,788**	**116,972**	.....	.....	**1,185**
March, 1935 (4 weeks)	5,734	32,101	12,736	12,582	17,479	10,326	90,958	.....	.....	5,714
April, 1934 (4 weeks)	5,864	23,989	12,791	15,896	33,263	9,389	101,192	.....	.....	1,435
Four months, 1935	27,857	103,016	81,822	68,516	79,556	63,516	.....	424,283	.....	15,979
Four months, 1934	25,969	87,018	110,542	76,489	131,482	54,738	.....	.....	486,238	9,266

ENGINEERING CONSTRUCTION REPORTED BY E.N.-R.-WEEKLY AVERAGES

□ ---1934 ■ —1935



however, was an increase of 4 points over the February ratio.

Total production for the first quarter of 1935 amounts to 10,554,000 bbl., compared with 13,204,000 bbl. in the same period last year, a drop of about 20 per cent. Shipments for the first quarter this year amounted to 10,675,000 bbl., compared with 11,348,000 bbl. in the same period last year, or a drop of 6 per cent.

Steel—The operating rate of steel companies having 98.7 per cent of the steel capacity of the industry decreased the first two weeks of April and increased in the second half of the month according to reports of American Iron and Steel Institute. The average rate was 44.2 compared with an average of 48.8 for April last year.

March bookings of fabricated structural steel showed a marked upturn according to the American Institute of Steel Construction based on reports from shops representing 79 per cent of the total industry. The recovery, however, was not sufficient to offset the losses sustained during January and February. The average bookings for the first quarter this year were approximately ten per cent less than the average monthly bookings last year, although the bookings of March this year alone were twenty per cent larger than the monthly average of last year.

The shipments during March were on the average less than the monthly shipments during the previous nine months, but about 13 per cent larger than for the monthly average during the first half of 1934.

Lumber—Production reported by the National Lumber Manufacturers Assn., for the first quarter was 1 per cent lower than last year while shipments showed an increase of 23 per cent and orders an increase of 18 per cent.

April started off with the highest production since October, 1934 but new business booked was light and shipments while under the high weeks of March compared favorably with the average for the year. In the following two weeks production was lower but shipments were 13 and 18 per cent heavier and orders increased 22 per cent and 25 per cent respectively.

Production for the week ending April 19, was 186,173,000 ft., shipments 201,389,000 ft., and orders, 213,295,000 ft.

Building Permits

The March volume of building permits for 215 cities of the United States, as compiled by Dun & Bradstreet, Inc., was the largest since April, 1932, and represented a total value of $45,056,822, as compared with $27,636,367 in February. This was an increase of 63.0 per cent, as against a normal seasonal gain of about 53.0 per cent. Marked improvement was also shown over the corresponding month of last year. Comparison with the March, 1934, total of $25,505,005 reveals a rise of 76.7 per cent.

The volume of permits for the 214 cities outside of New York increased to $33,609,654 during March, compared with $21,783,459 in the preceding month and $19,804,760 in the same period of last year, representing increases of 54.3 and 69.7 per cent, respectively.

At New York City, the value of permits issued jumped to $11,447,168, a gain of 95.6 per cent above the February total of $5,852,908, and 100.8 per cent higher than March a year ago, when permits were valued at $5,700,245.

This March increase in building construction was also reported by the Bureau of Labor Statistics of the U. S. Department of Labor. Compared with the previous month the value of the buildings for which permits were issued in the principal cities of the country shows an increase of 53.5 per cent.

In comparison with the same month a year ago the number of building permits issued in March 1935 shows an increase of 42.9 per cent and the estimated cost of the buildings for which permits were issued shows an increase of 74.5 per cent. The most pronounced increase over a year ago was in the value of new residential buildings. The increases in residential construction, moreover, were country-wide, ranging from 20 per cent in New England to more than 500 per cent in the South Atlantic region. Appreciable gains are shown also in the number and estimated cost of new non-residential buildings, and of additions, alterations, and repairs. These comparisons are based on reports from 761 identical cities.

The per cent of change from March 1934 to March 1935 is shown in the following table:

Type of building	Per Cent Number	Per Cent Estimated cost
New residential	+175.3	+130.9
New non-residential..	+ 15.6	+ 60.7
Additions, alterations, repairs	+ 39.4	+ 48.9
Total	+ 42.9	+ 74.5

The per cent of change from February 1935 to March 1935 for the different types of construction is shown below:

Type of building	Per Cent Number	Per Cent Estimated cost
New residential	+114.1	+103.2
New non-residential..	+ 81.8	+ 33.7
Additions, alterations, repairs	+ 53.2	+ 40.2
Total	+63.8	+ 53.5

Prices

As a whole prices are steady. Lumber prices are lower in several centers, cement prices have increased at several mills and centers. Steel prices are steady except for minor adjustments on account of the new freight rates.

Labor

Employment on construction in New York State dropped in March for the third consecutive month according to report of the Department of Labor, State of New York. Reductions in employment were reported as follows: for highway contracting, 46.9 per cent; for general building, 14.5 per cent; for miscellaneous general contracting, 6.4 per cent and for subcontracting, 5.7 per cent. These statements are based on reports of more than 1,000 contractors operating in New York State.

Few labor controversies are reported for April. Agreement was reached at Albany by the Painters, Paperhangers and Decorators Union, Local 201, and the Master Painters Association of Albany, after a long discussion when representatives of both groups accepted the compromise rate of $7.50 a day or 93¾ cents an hour. The rate, which is 16¼ cents less than that first demanded by the union and 6¼ cents less than the rate accepted by the contractor on the new Post Office, will be effective until May 1, 1936. The previous union scale was 87½ cents an hour.

In New Jersey eight laborers' local unions in Essex County have signed agreements with the Associated Contractors of New Jersey setting a wage scale of 87½ cents an hour for an eight-hour day. This is a reduction from the rate of 95 cents an hour prevailing under the last agreement, which expired April 1. The new agreement runs from April 1 to July 31, 1936. This change was made to bring the agreement into line with that of the bricklayer's locals date.

EN-R Cost and Volume Index

THE *Engineering News-Record* Construction Cost Index for May is 194.06 compared with 194.50, for April. The change is due to slight decrease in labor.

The *E.N.-R.* Volume Index for April is 130 compared with 101 last month, and 109 a year ago.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
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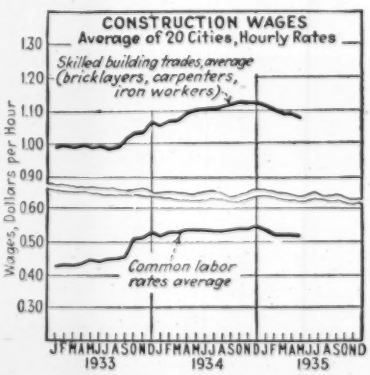
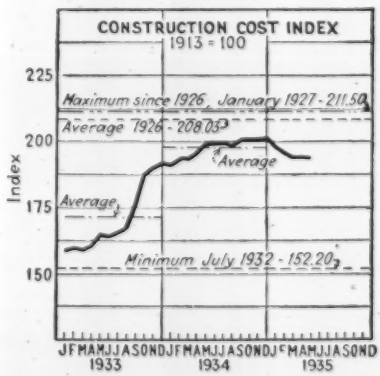
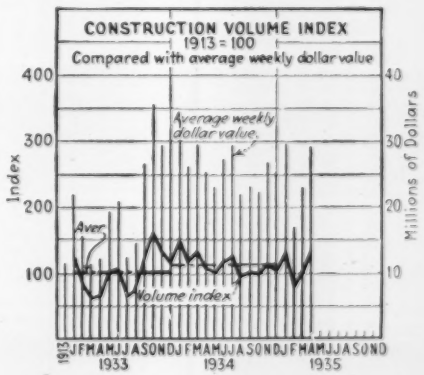

CONSTRUCTION WAGES
Average of 20 Cities, Hourly Rates
Skilled building trades, average (bricklayers, carpenters, iron workers)
Common labor rates average
Wages, Dollars per Hour
1.30
1.20
1.10
1.00
0.90
0.60
0.50
0.40
0.30
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935


CONSTRUCTION COST INDEX
1913 = 100
Maximum since 1926, January 1927 - 211.50
Average 1926 - 208.05
Average
Average
Minimum, July 1932 - 152.20
Index
225
200
175
150
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935



CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50c. yd. or more, delivered)
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.89	$2.64	$2.44	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$8.25
Baltimore	2.66	2.41	2.21	1.80‡	2.00‡	1.25‡	1.80‡	1.80‡	2.25	2.25	7.35
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.45
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	....	....	7.00
Chicago	2.95‡	2.70‡	2.40	2.60‡	2.60‡	2.05‡	2.60‡	2.60‡	....	....	....
Cincinnati	2.57	2.32	2.12	1.20	1.20	1.10	1.80	1.80	....	....	6.70
Cleveland	2.45	2.20	....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	8.85
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	2.10	2.25	....	....	7.00
Denver	3.08	2.83	....	1.85	....	1.25	....	....	....	....	....
Detroit	2.25	2.00	1.80	1.40	1.30	1.20	1.40	1.50	1.40‡	1.50‡	6.25
Kansas City	2.50	2.25	2.05	....	1.85	1.15	1.85	1.40-1.55	....	....	7.65
Los Angeles	2.70	2.42	....	1.60	1.60	1.20	1.60	1.60	....	....	6.70
Minneapolis	2.90	2.45	2.40	1.00p	1.00p	.25p	1.00p	1.00p	....	....	6.50
Montreal	....	1.70	....	.85	.90	.40	.85	.95½	....	....	6.00
New Orleans	2.40	2.22	2.00	1.75	1.75	1.45	....	....	....	....	8.25
New York	2.60‡	2.35‡	....	1.30†*	1.30†*	.85†*	1.75†*	1.85†*	....	....	7.60
Philadelphia	2.60	2.35	2.15	1.80‡	1.90‡	1.50‡	1.75‡	2.00‡	1.75‡	1.75‡	7.75
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.52	2.27	....	1.90‡	1.90‡	1.40/1.90	.75p	.75p	.65/.95§A	.50/.95§B	6.65
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.53
Seattle	2.95	2.70	....	1.00	1.00	1.00	1.44	1.44	....	....	7.56

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. A Above 5/16" size, B 5/16" and below—new code sizes. aBarge lots alongside dock. pf.o.b. plant. p5 tons or more.

CURRENT MAXIMUM NET PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.50	$1.45	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala.	$1.75	$1.70
Buffington, Ind.	1.70	1.65	Iola, Kans.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Crestmore, Calif.	1.72	....	La Salle, Ill.	1.60	1.55	Saginaw, Mich.	1.50	1.45
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Norfolk, Va.	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans.	1.70	1.65	Northampton, Pa.	1.65	1.60	Wyandotte, Mich.	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over)			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over)			BRICK (Per M, in quantity)		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	in paper, Common hydrated	carload lot, Pulverized or lump
Atlanta	$75.80	$80.80	$151.60	$181.90	$212.20	$242.50	$14.25	$14.25	$24.00	$17.00	$15.90
Baltimore	74.50	80.00	150.00	180.00	208.00	260.00	13.00	17.00	16.75	11.25	19.00
Birmingham	84.25	90.00	156.00	180.00	215.00	242.00	15.00	22.50	3.00§	1.75§	2.25§*
Boston	85.30	91.15	171.00	193.50	239.60	273.40	14.50	18.00	18.75	13.75	3.26q*
Chicago	66.00	70.40	132.00	....	....	....	10.20	11.20	18.00	13.40	14.00
Cincinnati	69.95	74.60	139.90	139.90	174.65	199.20	17.50	17.50	15.97	12.48	....
Cleveland	62.50	66.50	124.50	149.50	188.00	214.75	16.50	16.50	17.20k	14.40k	2.65kp
Dallas	72.00	75.00	197.00	177.00	217.00	269.00	13.50	26.00	21.20	14.50	1.70 p
Denver	78.50	88.00	141.50	166.50	196.00	225.00	10.00-15.50	21.00-30.00	25.00	17.00	20.00
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	11.50	12.50	14.25	11.90	22.00
Kansas City	72.50	75.50	92.00*	140.50	177.75	207.25	15.00	24.00	15.00	11.25	14.00*
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	21.00	23.00
Montreal	79.10s	90.40	169.50s	....	212.40	....	17.00	22.50	23.00	13.00	....
New Orleans	61.60	65.70	123.20	158.90	196.70	....	14.00	....	16.75	13.05	....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	11.50	....	20.80	16.00	20.80
Philadelphia	80.50	85.90	161.00	182.50	235.00	272.00	15.00	18.00	16.35	11.25	10.75
Pittsburgh	72.65c	77.45c	145.00c	165.00c	217.00c	250.00c	17.50	22.00	16.70	15.10	2.75p
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.80p
San Francisco	84.00	94.50	225.00	....	....	....	15.00	18.00	22.50	21.50	2.05p
Seattle	86.00	94.50	210.00	198.00	....	....	15.00d	18.50	30.00	26.00	3.00p

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. pPer bbl. 180 lbs. qper bbl. 280-lb. kLCL. dless $1 cash 15 days. tlump. cSmooth. x Selected common.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS		ASPHALT EMULSION	
	Granite per M, lots of 50,000, 4x4x8 in.,	Brick per M, 3x8½x4 in., carload lots	Wood per sq.yd., 3½ in., 16-lb. treat,	Per ton, less than 80 penetration, Tank car	Drums	Per gal., 80-300 penetration, Tank car	Drums	Per ton, Tank car	Drums	Per gal., Tank car	Per gal., Tank car	Per gal., Tank car	Drum
Atlanta	$ 80.00	$35.00	$2.25	$17.40z	$22.47z	$0.0694z	$0.961z	$19.65z	$25.57z	$0.0694z		$0.105	$0.105
Baltimore	110.00	44.00	2.35	17.00	22.00	.07	.095	.085†	.12†	....		....	....
Birmingham	110.00	24.00	....	18.00	23.00	0.778	.1028	.082†	.112†	....		.06	....
Boston	85.00	30.00	2.75	16.00	21.00	.075	.10	.09†	.12†	.075		.09	.125
Chicago	138.00	42.00	2.60	....	....	....	....	....	....	....		....	....
Cincinnati	115.00	37.00	....	18.00	22.00	.09	....	18.50	....	.07		.08	....
Cleveland	100.00‡	32.75	2.95	20.00	24.50	.075	.09	.075†	.049†	.06		.085	.10
Dallas	....	30.00	....	16.10	21.10	.052§	.10	15.65	23.15	.055		.1076	.1438
Detroit	....	37.00	....	19.67a	24.87a	....	....	17.00	22.50	....		.0957	....
Kansas City	....	45.00	....	18.30	23.30	17.30#	22.30#	.075†	.105†	.055		.11	.15
Los Angeles	....	50.00	....	10.34	14.50	10.34#	14.50#	10.34	....	.042		.06	.12
Minneapolis	....	....	2.50	18.20	24.70	.098	.098	21.85	34.65	.048		....	....
Montreal	....	110.00	....	14.00	19.66	.07	.093	19.00	26.00	.07		.125	.155
New Orleans	100.00	32.00	....	14.50	18.50	.065	.09	.07†	.10†	....		....	....
New York	125.00§	50.00	2.64	17.00	22.00	.07	.095	.085†	.12†	....		.075	.11
Philadelphia	115.00	45.00	2.25	15.50	20.00	.05	.08	.06†	.09†	.05		.02	....
Pittsburgh	120.00	40.00	....	19.00	24.00	.0775	.1125	.086†	.121†	.0675		....	....
St. Louis	117.50	35.00	2.00	19.50	24.50	.078	.108	.088†	.118†	.04		.09	.125
San Francisco	....	50.00	....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04		.0575	.117
Seattle	....	55.00	....	17.00	23.00	17.00#	23.00#	15.00	....	.03		.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½ in. §4x5x9-in. Av. aMexican. zIocal reduction due to 20% reduction intra-state class freight rates, only Georgia affected. #Per ton

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet,	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$1.95	$2.10	.....	.....	.....	$36.375	$34.375	$35.00	$2.55	$2.40	$1.90	$3.55
Chicago	1.85	2.10	$3.00	.....	$2.25	36.375	35.00	34.00	2.55	2.40	1.90	3.55
Pittsburgh	1.80	2.05	2.90	$2.60	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—BASE MILL PRICES, PER 100 LB., CARLOAD LOTS

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price New billet	Rail steel	EXPANDED METAL LATH —Per 100 sq yd., carload lots— Std. diamond mesh, 3.4 lb	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING —Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No 8 & 12 wires	6x6 in., No 6 & 6 wires Per sq yd	SHEET PILING Per 100 lb., base price
Atlanta	$3.34	$2.32	$2.17	$21.00	$24.00	$1.53	$1.16	$0.1449	$2.65
Baltimore	2.95	2.75	2.60	22.00	25.00	1.41	1.08	.1332	2.75
Boston	3.52	3.03	2.2125	20.50	24.50	1.46	1.12	.1449	2.30
Chicago	3.20	2.10	1.95	22.00	26.00	1.40	1.08	.1323	2.25
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1287	.....
Cleveland	3.16	2.60	2.45	20.00	22.00	1.37	1.06	.1287	.....
Dallas	3.25	2.80	2.65	22.00	25.00	1.63	1.23	.1548	2.985
Denver	3.93	3.87	.....	25.00	27.50	1.68	1.26	.1548	.....
Detroit	3.40	2.885	2.885	20.00†	22.00†	1.41	1.08	.1323	2.25
Kansas City	3.68	2.68	2.53	19.00	22.00	1.50	1.14	.1422	2.67
Los Angeles	3.10	2.95	.....	23.00	27.50	1.68	1.26	.1584	2.50
Minneapolis	3.45	2.86	2.71	22.00	26.00	1.51	1.15	.1431	2.55§
Montreal	2.75	3.00	2.80	.....	.....	2.30	1.71	.238	2.65
New Orleans	.....	.....	.....	19.15	23.00	1.54	1.17	.1458	.....
New York	3.37	2.86	2.71	20.00	22.00	1.44	1.11	.1359	2.48
Philadelphia	2.005	2.34	2.19	20.00	23.50	1.42	1.09	.1332	2.44
Pittsburgh	1.80‡	1.80‡	1.70‡	20.75‡	23.00‡	1.34	1.04	.1260	2.15
St. Louis	3.44	2.94	2.79	22.00	24.00	1.42	1.09	.1341	2.25
San Francisco	3.55	2.475	2.35	23.00	28.00	1.68	1.26	.1584	2.60
Seattle	3.50	2.50	.....	30.00	33.00	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. †f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots# in oil	READY-MIXED PAINT Per gal., drums Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. factory Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal	Tar pitch, 350-lb. bbl., per ton
Atlanta	$7.75	$10.50	$1.60	$3.10	.....	$1.81	$1.97	$2.90	$ .36	$25.40
Baltimore	7.00	10.00	1.40	2.25	$1.90	2.32	2.55	2.55	.48	24.60
Birmingham	7.25	10.50	2.35	2.35	1.85	1.95	1.79	.....	.36	23.00
Boston	7.00	10.00	1.85	2.75	.04‡x	2.05	3.00	3.00	.43	0.00
Chicago	7.00	10.00	1.85	2.45	1.30	1.60	1.59*	1.59*	.24	20.00
Cincinnati	7.00	10.00	1.45	2.50	1.40	2.40	2.39*	2.39*	.36	21.00
Cleveland	7.00	10.00	1.65	2.30	1.30	1.60	1.79	1.79*	.24	22.00
Dallas	7.25	11.00	1.80	2.24	.....	2.40g	4.17	4.17	.15	35.00
Denver	7.50	10.75	2.55	.....	.....	2.75	3.46	3.46	.60	30.00
Detroit	7.00	10.00	1.45	2.20	1.30	2.55	2.80	2.80	.37	30.00
Kansas City	7.00	10.12½	1.25	2.25	1.00	2.05	3.10–3.20	3.10–3.20	.23	26.50
Los Angeles	7.25	10.25	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.12½	.....	.....	.....	1.60	1.79*	1.79*	.29	25.10
Montreal	.....	9.40	1.70	3.45	1.65	2.00	2.62	2.02	1.40§	1.52§
New York	7.00	10.00	1.65	2.20	1.45	1.60	1.79*	1.79*	.232	22.00
Philadelphia	7.00	10.00	1.50	2.05	1.50	1.68	1.85*	1.85*	.34	22.00
Pittsburgh	7.00	10.00	1.05	1.95	.80	1.75	1.65*	1.65	.38	22.00
St. Louis	11.00	11.00	1.85	2.45	1.30	1.87*	3.22	3.22	.28	20.00
San Francisco	7.25	9.75	1.80	2.75	1.10–2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	9.75	1.80	2.85	2.25	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. *Per roll, 65 lb. xPer lb. #500-lb. drums.
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928

	Single or Double Thickness A quality	B quality
Atlanta	85%	85%
Baltimore	88–10%	90–10%
Birmingham	88%	90%
Boston	88–10–5%	90–10–5%
Chicago	90%	92%
Cincinnati	89–10%	91–10%
Cleveland	89–10%	91–10%
Dallas	87½%	89%
Denver	84%	86%
Detroit	87–10%	89–10%
Kansas City	88–10%	90–10%
Los Angeles	90%*	90–40%
Minneapolis	85%	87%
Montreal	.....	.....
New Orleans	88%	90%
New York	88%	90%
Philadelphia	88–30%	90–30%
Pittsburgh	88%	88%
St. Louis	90%	92%
San Francisco	90%	90–10%
Seattle	90–10%	90–20%

*Disc. from list Aug. 1, 1929.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases

	Gelatin 40%	60%
Atlanta	$0.155	$0.17
Baltimore	.16	.175
Birmingham	.105	.120
Boston	.17	.1725
Chicago	....	....
Cincinnati	.27	.29
Cleveland	.19	.205
Dallas	.17	.185
Denver	.155	.17
Detroit	.237	.255
Kansas City	.16	.175
Los Angeles	.1725†	.1925†
Minneapolis	.17	.185
Montreal	.1875	.2125
New Orleans	.19	.22
New York	.225	.24
Philadelphia	....	....
Pittsburgh	.11	.1250
St. Louis	.135	.15
San Francisco	.1575	.1775
Seattle	.1425	.1575

†F.o.b. Arsenal. ‡Double thickness A & B

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90@$2.15
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00@35.00
Chlorine cylinders, per lb. delivered	.05½
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb	1.20
Sulphate of aluminum, commercial, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb	5.85

PILES

Prices per linear foot, pine, with bark on f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail	Long Leaf Barge	Long Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.12	$0.165	$0.13	$0.16
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.16	.21	.15	.20
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.17	.225	.16	.21½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.195	.235	.20½	.24½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2125	.245	.24½	.30½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.275	.385	.....	.....
14 in.—2 ft. from butt	5 in.	85 to 89 ft	.315	.452	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:

		6 in. x 8 in. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.15	$1.60
	Pine, untreated	1.15	1.60
	Pine, creosoted	1.60	2.25
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	no market	
	Southern pine, untreated *6x8x8'6"	.45*	.60
	Southern pine, creosoted	1.00*	1.20
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.50	.72
	Fir, creosoted	1.67	2.40
Philadelphia	Red oak, untreated	1.05	1.35
	Red oak, creosoted	1.50	1.90
St. Louis	White oak, untreated	1.10	1.45
	Red oak, untreated	1.08	1.40
	Red oak, creosoted	1.45	1.95
San Francisco	Sap Pine or cypress, untreated	.83	1.25
	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.10
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, standard (‡ f.o.b.) 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-24 12 in.	24 in.	Full standard weight. # 1 to 3 in., Black	Butt Weld Galv	3½ to 6 in., Black	Lap Weld Galv.
Atlanta	$42.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.55	$1.60	44%	37%	42%	34%
Baltimore	45.50	.24	.46	2.05	5.65	105.00	165.00	.75	2.00				
Birmingham	38.00	.25	.45	1.625	4.66	85.00	200.00	.45	1.60	48.939%	37.918%	50.162%	39.143%
Boston	45.50	.231	.4455	2.025	5.945	60.10	101.00	.54	1.90				
Chicago	46.00	.28	.54	1.98	5.60	85.00	120.00	.675	2.25	56%	45%	55%	57%
Cincinnati	45.00	.231	.4455	1.935	5.8425	69.00	108.00	.40	1.40	53.04%	42.02%	54.265%	43.249%
Cleveland	46.50	.21	.405	1.71	5.2275	47.25	72.00	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	50.00	.25	.45	1.80	.....	160.00	250.00	.41	1.41	64%	55%	64%	56%
Denver	58.00	.23‡	.415‡	1.73‡	.....	.....	.....	.....	.....	56%	45%	43%[k]	57%[k]
Detroit	46.50	.245	.4725	2.025	5.74	58.10	97.20	.35	1.55	48.6%	38.2%	47.3%	37.6%
Kansas City	48.00	.32	.57	2.27	4.90	120.00	240.00	.35	1.20	58%	49%	59%	50%
Los Angeles	46.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	48.50	.283	.51	2.04	5.13	.....	.....	.50	1.34	.....	.....	.....	.....
Montreal	.....	.80	1.50	6.00	.....	45.00	90.00	.45	.....	.....	.....	.....	.....
New Orleans	44.00	.30	.50	1.65	.....	65.00	.....	.45	2.00	.....	.....	.....	.....
New York	45.00	.26	.51	2.25	6.75			.55	2.00	51.88%*	40.86%*	53.10%*	42.08%*
Philadelphia	42.00	.315	.6075	2.70	.....	150.00	230.00	.....	.....	52.37%*	41.35%*	53.39%*	42.57%*
Pittsburgh	48.00	.224‡	.432‡	1.845‡	5.535‡	69.00	108.00	.75	1.75	64%	55%	65%	56%
St. Louis	45.80	.22	.396	1.584	3.96	85.00	172.00	.80	2.28	51.51%	40.49%	52.74%	41.71%
San Francisco	46.00	.265	.477	1.908	5.22	103.50	172.50	.45	2.20	52.4%	63.4%	51.1%	64.6%
Seattle	47.50	.34†	.60†	2.40†	6.30†	85.00	200.00	1.50	1.60	60.3%	51.3%	65.3%	52.3%

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $42.00. Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less. ‡Price at factory. †Less 30% in C/L Lots.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c; ⅜ in. 11½c.; ½ in. 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.
[k]2½ to 3 in. *Resale price to consumer, car load lots shipped from mill.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.									LONG LEAF Y. P. Merchantable grade up to 20 ft.	
		1x6,[S]	1x8,[S]	2x4,[S]	2x6,[S]	2x8,[S]	2x10,[S]	3x12,[R]	6x12,[R]	12x12,[R]	2x12,[R]	12x12,[R]
Atlanta	Southern Pine	$14.00	$14.00	$17.00	$16.50	$18.00	$18.50	$27.00	.....	.....	$38.50	$40.00
Baltimore	Southern Pine	23.00	23.00	28.50	28.00	28.00	30.50	37.00			54.00	55.00
	Douglas Fir	28.00	28.00	30.00	28.00	30.00	30.50	30.00	$30.00	$30.00		
Birmingham	Long Leaf	13.25	14.25	16.25	14.25	15.25	15.25	37.00			27.00	34.80
	Southern Pine	13.25	14.25	15.00	13.00	14.00	14.00	24.00	24.00	23.00	.....	.....
Boston	Southern Pine	32.00	33.00	40.00†	42.00†	55.00‡	64.00‡	76.00‡	.....	.....	76.00	76.00
	Douglas Fir	31.00	32.00	40.00	40.00	40.00	42.00	43.00	45.00	45.00		
Chicago	Southern Pine	27.00	28.00	33.50	30.00	31.00	32.80	45.00			54.00	58.00
	Douglas Fir	28.50	29.50	31.50	30.50	30.50	28.50	40.75	41.75	41.75	.....	.....
Cincinnati	Southern Pine	24.00	25.00	26.00	25.00	25.50	26.50	40.00	.....	.....	31.50	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.50	46.25	46.25	.....	.....
Cleveland	Southern Pine	26.00	27.00	31.00	27.00	28.00	30.00	43.00	43.00	.....	46.00	55.00§
Dallas	Southern Pine	d28.35	30.60	31.50	29.80	30.15	30.15	50.40	.....	.....	42.75	67.95
Denver	Douglas Fir	38.00	39.00*[n]	40.00*	40.00*	40.00*	42.00*	49.00*	53.00*	58.50	.....	.....
Detroit	Southern Pine	24.00	24.00	25.00	24.50	24.50	25.50	35.00			29.00	41.50
	Douglas Fir	.....	.....	.....	.....	.....	.....	41.50	41.50	41.50	.....	.....
Kansas City	Southern Pine	22.50	23.50	23.50	22.50	23.50	24.50	35.00			47.50	57.50
	Douglas Fir	22.75	23.75	26.00	25.00	25.00	26.50	35.00	35.00	35.00	.....	.....
Los Angeles	Douglas Fir	24.00[y]	25.50[y]	26.00[y]	26.00[y]	26.00[y]	26.00[y]	38.00[y]	30.00[y]	34.00[y]	.....	.....
Minneapolis	Western Pine	43.00*	41.00*	34.00*	31.50*	32.00*	33.30*	46.00*[k]			.....	.....
	Douglas Fir	30.00*	32.50*	33.50*	31.50*	32.00*	33.00*	45.00*	46.00*	46.00[k]	46.00	.....
Montreal	Spruce	30.00	31.00	27.00	29.00	30.00	35.00	38.00				.....
	Douglas Fir	42.50	42.50	42.50	44.00	44.00	45.75	51.00	51.00	51.00	43.00	.....
New Orleans	Southern Pine	25.00	27.00	32.70	27.50	30.00	30.00	41.00	.....	.....	45.00	55.00
	Douglas Fir	28.95	31.50	33.90	29.35	32.90	33.95	37.95	.....	.....	.....	.....
New York	Southern Pine	32.00*	33.00*	32.00*	33.00*	34.00*	35.00*	45.00*			70.00*	70.00*
	Douglas Fir	.....	.....	36.00*	35.00*	36.00*	37.00*	36.00*	39.00*	39.00*	.....	.....
Philadelphia	Southern Pine	24.50	25.50	27.00	25.50	26.50	27.00	31.00			61.00	59.00
	Douglas Fir	.....	.....	31.00	31.00	31.00	31.00	32.50	32.50	33.50	.....	.....
Pittsburgh	Southern Pine	26.50	27.75	32.75	29.25	31.75	32.75	41.50	.....	.....	57.50	57.50
	Douglas Fir	33.50	34.50	34.50	33.50	34.00	34.25	46.25	46.25	46.25	.....	.....
St. Louis	Southern Pine	29.50*x	30.00*x	31.00*x	30.00*x	30.50*x	33.00*x	55.00*x			56.00*x	67.00*x
	Douglas Fir							55.00*x	55.00*x	55.00*x	.....	.....
San Francisco	Douglas Fir	15.00[f]	16.00[f]	17.00[f]	14.50[f]	15.50[f]	16.50[f]	21.00	21.00[f]	21.00[f]	.....	.....
Seattle	Douglas Fir	13.00	14.00	14.00	11.50	12.50	12.00	18.50	18.00	18.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. [n]Northern Pine. [w]Native. [f]At ship's tackle. [y]Yard prices. d10% Disc taken off. x5M ft. or less. [S]S4S. [R]Rgh.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor — Building	Common Labor — Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.40
Birmingham	1.00	.60/1.00	1.00	1.125	1.00	.30/.40†	.30/.40†
Boston	1.20	.70/1.17½	1.20	.90/1.37½	1.37½	.40/.70	.40/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.90/1.375	.45	.45
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.25	1.25	.72	.72
Dallas	.50/1.00	.50/1.00	50/1.00	.50/1.00	.50/1.00	.25/.40	.25/.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.55/.60	.55/.75
Kansas City	1.32½	1.12½	1.125	1.12½	1.32½	.70	.45/.50
Los Angeles	1.10	1.10	1.125	1.10	1.25	.50	.60
Minneapolis	.90/1.00	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.82½	.50/.82½
Philadelphia	.75/1.20	.60/1.20	1.00/1.20	.75/1.20	.60/1.20	.30/50	.30/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.37½	1.50	.78½	.35/.78
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.62½	.60
Seattle	.90/1.00	.90/1.00	1.00/1.30	1.00/1.25	.90/1.50	.45/.65	.50/.65
Montreal	1.00	.70	.80	.55	.80	.40	.25

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.0793. Common Avg. $0.5233 *6-hr. Day. † PWA.